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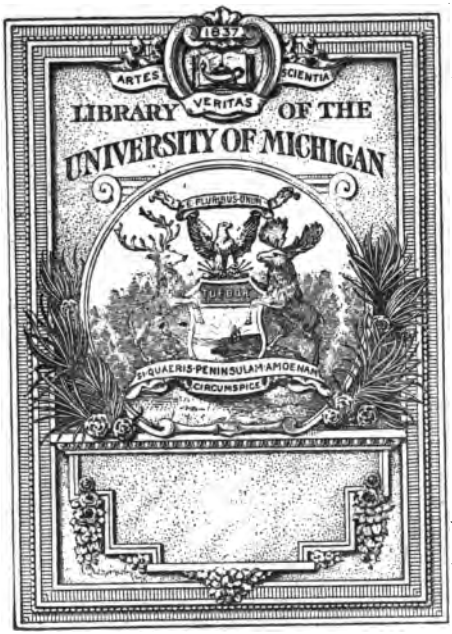
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OF

GAS ENGINEERS AND MANAGERS

—UNITED KINGDOM—

ASSOCIATIONS

OF

GAS ENGINEERS AND MANAGERS

—UNITED KINGDOM—

REPORTS OF PROCEEDINGS

DURING

1893

OF THE

Eastern Counties Gas Managers' Association,
Manchester District Institution of Gas Engineers,
Midland Association of Gas Managers,
North British Association of Gas Managers,
North of England Gas Managers' Association,
North of Ireland Association of Gas Managers,
Scottish Gas Managers at Glasgow,
Southern District Association of Gas Engineers and Managers,
South-West of England District Association of Gas Managers,
AND
Waverley Association of Gas Managers.

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CONTENTS.

EASTERN COUNTIES GAS MANAGERS' ASSOCIATION— PAGE
Half-Yearly Meeting at Cambridge, March 13. 48
Half-Yearly Meeting at Melton Mowbray, Sept. 13. . . . 286

MANCHESTER DISTRICT INSTITUTION OF GAS ENGINEERS—
Annual Meeting in Manchester, March 4 33
Quarterly Meeting at Northwich, May 13. 124
Quarterly Meeting at Nottingham, Sept. 1 and 2. 260
Quarterly Meeting in Manchester, Nov. 25. 361

MIDLAND ASSOCIATION OF GAS MANAGERS—
Annual Meeting at Birmingham, Feb. 16 18
Quarterly Meeting at Worcester, May 25 125
Quarterly Meeting at Birmingham, Oct. 26. 323

NORTH BRITISH ASSOCIATION OF GAS MANAGERS—
Annual Meeting in Dundee, July 27 and 28 127

NORTH OF ENGLAND GAS MANAGERS' ASSOCIATION—
Half-Yearly Meeting in Newcastle, April 29 103
Half-Yearly Meeting at Middlesbrough, Oct. 7 307

NORTH OF IRELAND ASSOCIATION OF GAS MANAGERS—
Annual Meeting at Coleraine, Aug. 8. 216

SCOTTISH GAS MANAGERS—
Annual Meeting in Glasgow, April 12. 85

SOUTHERN DISTRICT ASSOCIATION OF GAS ENGINEERS AND MANAGERS—
Annual Meeting in London, Feb. 9 1
Excursion Meeting—Visit to Hampton Court, May 25. . . 126
Quarterly Meeting in London, Nov. 23 325

SOUTH-WEST OF ENGLAND DISTRICT ASSOCIATION OF GAS MANAGERS—
Half-Yearly Meeting at Wormwood Scrubbs, April 11. . . 59
Half-Yearly Meeting at Exmouth, Sept. 12. 269

WAVERLEY ASSOCIATION OF GAS MANAGERS—
Half-Yearly Meeting at Dalkeith, April 13 99

198539

ILLUSTRATIONS, &c.

TO FACE PAGE

PLATE I.—Diagrams and Table referred to in the Paper by Mr. A. Bell, jun., on the Production of Illuminating Gas from Liquid Hydrocarbons by the Peebles Process. 164

„ II.—Diagrams illustrating Mr. Gilbert Little's Paper on Automatic Appliances for Small Gas-Works . . . 208

PAGE

FIG. 1.—Diagram showing the Variations in Prices of Gas, Coal, and Labour in London for the Seventy Years ending 1893 40

„ 2.—Stagg's Appliances for Testing Seal in Hydraulic Mains 76

„ 3.—Stagg's Appliance for Reducing the Aperture in the Photometer Burner 79

„ 4.—Stagg's Arrangement of Pressure-Gauges 80

„ 5.—Hislop's Regenerative Retort-Setting—Elevation and Section 118

„ 6.—Ditto—Cross Section 119

„ 7.—The Yeadon Revolving Retort 191

„ 8.—General Plan of the Oil-Gas Plant at the Inchicore Works, Dublin 231

„ 9. } Setting of Oil-Gas Retorts at the Inchicore Works,
„ 10. } Dublin—Cross and Longitudinal Sections. 232

„ 11. } Ditto—Front and Back Elevations 233
„ 12. }

INDEX.

PAGE

Armitage, Mr. C., on the Purification of Gas 35

Automatic Appliances for Small Gas-Works, Mr. Gilbert Little on 207

Ballantyne, Mr. J.—Paper on Cooking by Gas 198

Bell, Mr. A., on the Peebles Oil-Gas Process 99, 162

Carpenter, Mr. C. C.—Inaugural Address to the Southern District Association of Gas Engineers and Managers 3

Chadwick, Mr. J.—Paper on the Stacking of Coal, and Coal Haulage Machinery 361

Chester, Mr. W. R.—
- Inaugural Address to the Manchester District Institution of Gas Engineers 36
- Notes on the Nottingham Gas Supply 262

Coal—
- Analysis, Report of the Research Committee of the North British Association on 128
- Chadwick, Mr. J., on the Stacking of Coal, and Coal Haulage Machinery 361

Cooking by Gas—
- Ballantyne, Mr. J., on 198
- Main, Mr. A., on 239
- Manwaring, Mr. W. H., on 296

Duesbury, Mr. W.—Inaugural Address to the Eastern Counties Gas Managers' Association 50

Durkin, Mr. S. W.—Paper on Main Laying 280

Eastern Counties Gas Managers' Association—
- Annual Report of the Committee 49
- Election of Office Bearers 305
- Federation of Gas Associations 305
- General Business 48, 286, 305
- Hawkins, Mr. J. G., on the Purification of Coal Gas 287
  - Discussion 290
- List of Office Bearers and Members 381
- Manwaring, Mr. W. H., on Gas Cookers 296
  - Discussion 302
- President's (Mr. W. Duesbury's) Inaugural Address 50

PAGE

Enriching Coal Gas (see also Oil-Gas Processes)—
Mackay, Mr. J., on, by Paraffin Oil or Liquid Hydrocarbons . 168
Thorne, Dr. L. T., on the Use of Oxy-Oil Gas for 325
Federation of Gas Managers' Associations, The Proposed, 70, 103, 125, 217, 269, 305
Hall, Mr. T. D.—Inaugural Address to the North British Association of Gas Managers 131
Hawkins, Mr. J. G.—Paper on the Purification of Coal Gas . . 287
Hislop's Regenerative Retort-Settings, Mr. Er W. Smith on 115, 317
Irving, Mr. D., on the Federation of Gas Managers' Associations 70
Keillor, Mr. G.—Notes on the Prepayment Meter 144
Liquid Hydrocarbons, The Production of Illuminating Gas from—
Bell, Mr. A., on 99, 162
Young, Mr. W., on 152
Little, Mr. Gilbert—Paper on Automatic Appliances for Small Gas-Works 207
Macadam, Mr. W. Ivison—Lecture on Processes for Manufacturing Gas from Oil, with Special Reference to the Peebles Process 246
Mackay, Mr. J., on Enriching Coal Gas by Paraffin Oil or Liquid Hydrocarbons 168
Main Laying, Mr. S. W. Durkin on 280
Main, Mr. A.—Paper on the History and Development of Cooking by Gas 239
Manchester District Institution of Gas Engineers—
Annual Report of the Committee 33
Armitage, Mr. C., on the Purification of Gas 35
Chadwick, Mr. J., on the Stacking of Coal, and Coal Haulage Machinery 361
Discussion 369
Chester, Mr. W. R., on the Nottingham Gas Supply 262
Election of Office Bearers 34, 361
General Business 33, 124
List of Office Bearers and Members 383
President's (Mr. W. R. Chester's) Inaugural Address. . . . 36
Visits to—
Manchester Ship Canal. 124
Nottingham 260
Manufacture of Gas, Mr. W. Stagg on the 74, 274
Manwaring, Mr. W. H.—Paper on Gas Cookers 296
Midland Association of Gas Managers—
Annual Report of the Committee 18
Election of Office Bearers 323
Federation of Gas Associations 125

PAGE

Midland Association of Gas Managers (*continued*)—
General Business 18, 125
List of Office Bearers and Members 386
President's (Mr. B. W. Smith's) Inaugural Address 20
Simpson, Mr. Peter, Presentation to 31
Visits to—
Birmingham (Windsor Street) Gas-Works 323
Smethwick Gas-Works 31
Tangyes, Limited 31
Worcester 125
Nelson, Mr. D. M.—Paper on the Yeadon Process of Gas Manufacture 189
North British Association of Gas Managers—
Annual Report of the Committee 127
Ballantyne, Mr. J., on Cooking by Gas 198
Bell, Mr. A., on the Production of Illuminating Gas from Liquid Hydrocarbons by the Peebles Process 162
Discussion 169
Coal Analysis, Report of the Research Committee on 128
Election of Office Bearers 214
General Business 127, 214
Keillor, Mr. G., on the Prepayment Meter 144
Discussion 147
List of Office Bearers and Members 388
Little, Mr. Gilbert, on Automatic Appliances for Small Gas-Works 207
Mackay, Mr. J., on Enriching Coal Gas by Paraffin Oil or Liquid Hydrocarbons 168
Murdoch Memorial Fund. 130
Nelson, Mr. D. M., on the Yeadon Process of Gas Manufacture 189
Discussion 194
President's (Mr. T. D. Hall's) Inaugural Address 131
Visit to the Dundee Gas-Works 215
Young, Mr. W., on the Principles of the Production of Illuminating Gas from Liquid Hydrocarbons 152
Discussion 169
North of England Gas Managers' Association—
Election of Office Bearers 123
Federation of Gas Managers' Associations 103
General Business 103, 123, 307, 322
List of Office Bearers and Members 394
President's (Mr. D. Terrace's) Inaugural Address 310
Smith, Mr. Er W., on Hislop's Regenerative Retort-Settings . 115
Discussion 317
Terrace, Mr. D., on the Yeadon Rotary System of Gas Making 104
Discussion 109

PAGE

North of Ireland Association of Gas Managers—
Annual Report of the Committee 216
Election of Office Bearers 218
Federation of Gas Associations 217
General Business 216, 258
List of Office Bearers and Members 397
Macadam, Mr. W. Ivison, on Processes for Manufacturing Gas from Oil, with Special Reference to the Peebles Process . . 246
Main, Mr. A., on the History and Development of Cooking by Gas 239
Discussion 243
Outon, Mr. C. B., on the New Oil Gas-Works at the Inchicore Works, Dublin 229
Discussion 237
President's (Mr. W. S. Stormonth's) Inaugural Address . . . 218
Whimster, Mr. J., Presentation to. 258

Nottingham Gas Supply, Mr. W. R. Chester on the 262

Oil Gas—
Macadam, Mr. W. Ivison, on 246
Peebles System, The (see Peebles)
Works at the Inchicore Works, Dublin 229

Outon, Mr. C. B.—Paper on the New Oil Gas-Works at the Inchicore Works, Dublin 229

Oxy-Oil Gas and its Use for Purposes of Enrichment, Dr. L. T. Thorne on 325

Peebles Oil-Gas Process—
Bell, Mr. A., on the 99, 162
Discussion on the, at the Meeting of Scottish Gas Managers . 87
Macadam, Mr. W. Ivison, on the 246
Young, Mr. W., on the 152

Prepayment Meter, Mr. G. Keillor on the. 144

Presidential Addresses—
Carpenter, Mr. C. C. (Southern District Association) 3
Chester, Mr. W. R. (Manchester Institution) 36
Duesbury, Mr. W. (Eastern Counties Association) 50
Hall, Mr. T. D. (North British Association) 131
Riley, Mr. E. C. (South-West Association) 59, 271
Smith, Mr. B. W. (Midland Association) 20
Stormonth, Mr. W. S. (North of Ireland Association) 218
Terrace, Mr. D. (North of England Association). 310

Purification of Coal Gas—
Armitage, Mr. C., on the 35
Hawkins, Mr. J. G., on the 287

Riley, Mr. E. C.—Presidential Addresses to the South-West of England District Association of Gas Managers 59, 270

PAGE

Scottish Gas Managers—
Chairman's (Mr. A. Wilson's) Address 87
Discussion 90
Visits to the—
Dawsholm and Temple Farm Gas-Works 85
Tradeston Gas-Works 96

Smith, Mr. B. W.—Inaugural Address to the Midland Association of Gas Managers 20

Smith, Mr. E W.—Paper on Hislop's Regenerative Retort-Setting 115, 317

Southern District Association of Gas Engineers and Managers—
Annual Report of the Committee 1
Election of Office Bearers 325
General Business 1, 325
Helps, Mr. J. W., Presentation to 16
List of Office Bearers and Members 399
President's (Mr. C. C. Carpenter's) Inaugural Address . . . 3
Thorne, Dr. L. T., on Oxy-Oil Gas and its Use for Purposes of Enrichment 325
Discussion 338
Visit to the Vauxhall Gas-Works and Hampton Court Palace . 126

South-West of England District Association of Gas Managers—
Durkin, Mr. S. W., on Main Laying 280
Discussion 282
Election of Office Bearers. 270
Federation of Gas Managers' Associations 70, 269
General Business 59, 269
List of Office Bearers and Members 402
President's (Mr. E. C. Riley's) Addresses 59, 270
Stagg, Mr. W., on the Manufacture of Gas 74
Discussion 274
Visit to the Kensal Green Gas-Works 82

Stacking of Coal, and Coal Haulage Machinery, Mr. J. Chadwick on the 361

Stagg, Mr. W.—Paper on the Manufacture of Gas 74, 274

Stormonth, Mr. W. S.—Inaugural Address to the North of Ireland Association of Gas Managers 218

Terrace, Mr. D.—
Inaugural Address to the North of England Gas Managers' Association 310
Paper on the Yeadon Rotary System of Gas Making 104

Thorne, Dr. L. T.—Paper on Oxy-Oil Gas and its Use for Purposes of Enrichment. 325

PAGE

Waverley Association of Gas Managers—Bell, Mr. A., on the Peebles Oil-Gas Process 99

Wilson, Mr. A.—Address to the Scottish Gas Managers . . . 87

Yeadon Rotary System of Gas Making—
Nelson, Mr. D. M., on the 189
Terrace, Mr. D., on the 104

Young, Mr. W.—Paper on the Principles of the Production of Illuminating Gas from Liquid Hydrocarbons 152

REPORTS OF PROCEEDINGS.

ASSOCIATIONS OF
GAS ENGINEERS AND MANAGERS
—UNITED KINGDOM—
1893.

SOUTHERN ASSOCIATION.

ANNUAL MEETING, FEB. 9.

This Meeting was held at the Holborn Restaurant. At the commencement of the proceedings, Mr. A. DOUGALL (of Tunbridge Wells), the retiring President, occupied the chair.

The minutes of the previous meeting having been taken as read,

The retiring President introduced his successor—Mr. C. C. CARPENTER, Engineer of the Vauxhall works of the South Metropolitan Gas Company.

REPORT OF THE COMMITTEE.

The HON. SECRETARY and TREASURER (Mr. J. W. Helps, of Croydon) then read the annual report of the Committee, as follows:—

In presenting the annual report of the Association, the Committee feel that they may fairly congratulate the members on the continued prosperity of the undertaking, and the useful and pleasurable character of the proceedings at the several meetings held during the past year.

At the annual meeting, held on the 9th of March last, the President—Mr. A. Dougall, of Tunbridge Wells—delivered a most interesting Inaugural Address. In briefly dealing with matters that had come within the range of his own experience, he succeeded admirably in describing the construction and methods of working adopted in a modern gas-works, and presented to his hearers much valuable information, and many ideas as to the management of gas undertakings well worthy of consideration.

By the kindness of the Directors of the Tunbridge Wells Gas Company, the President was enabled to invite the Association to hold the May meeting at the works under his charge; and the members were most cordially received by some of the Directors, and by the Secretary, Mr. J. Read. It was doubtless a matter of gratification to all connected with the Gas Company to conduct their visitors through works so well arranged, and containing such fine examples of gas engineering, maintained in the highest condition of working efficiency. After inspecting the works, the members were most hospitably entertained at a luncheon provided by the Directors of the Company; and the party then proceeded to Penshurst, where, by the kind permission of Lord de Lisle, they were shown over Penshurst Place, which has many historical associations, and contains pictures and other works of art of great interest. The drive home in the summer evening was a very enjoyable conclusion to the day's proceedings.

The next meeting of the Association was held on the 10th of November, at the Holborn Restaurant—Mr. Dougall presiding. Mr. C. C. Carpenter, of Vauxhall, read a paper on "Purification," in which he dealt with the effects of atmospheric air as used in the elimination of sulphur compounds from coal gas. In this, as in other matters connected with the manufacture of gas, Mr. Carpenter has struck out a distinct line for himself. His paper and the discussion which followed will doubtless form a valuable addition to the literature of the subject. At this meeting, Mr. Carpenter was unanimously chosen President for the ensuing year. Messrs. W. A. Valon and J. Tysoe were elected to the Committee in place of Messrs. S. W. Durkin and Corbet Woodall. The gentlemen who have kindly consented to act as Auditors are Mr. W. H. H. Broadberry (re-elected) and Mr. C. E. Botley, who will fill the vacancy occasioned by the election of Mr. Carpenter as President. Our excellent and highly-esteemed Honorary Secretary, Mr. J. W. Helps, again consented to fill the position for which he is so especially suited; and the Committee gratefully acknowledge how much both themselves and the members owe to his exertions on their behalf, and to his tact in securing the interests and maintaining the most worthy objects of the Association.

The finances of the Association have been conducted on the principles advocated, although not practised, by Mr. Micawber; expenditure being kept just within income—result, happiness. The receipts for the year 1892 were £52 8s., while the expenses amounted to £50 12s. 1d.; leaving a small balance to add to that already in hand—raising the sum carried forward to £44 6s. 3d.

The number of members at the end of 1892 was 91. Six new members were admitted to the Association during the year. On the other hand, its numbers were reduced by one resignation and by two deaths —viz., those of Mr. C. C. Broadberry and Mr. John Somerville. The last-named gentleman was a Past-President of the Association, and one of the most frequent contributors to the proceedings of the meetings;

while his unvarying kindness of disposition secured to him the love and respect of all with whom he ever came in contact. His memory will, we feel sure, receive due recognition by the members at the forthcoming meeting.

The Committee trust that the friendship and good feeling which have always existed among the members of the Southern District Association will be continued, and that each one will exert himself to contribute in some way to advance the objects of the Association, and so assist the industry we represent to hold its own against all competitors.

On the motion of Mr. T. PRICE (Hampton Wick), seconded by Mr. A. F. BROWNE (Rotherhithe), the report was adopted.

THE LATE MR. JOHN SOMERVILLE.

The PRESIDENT said that, since the last meeting, the Association had unfortunately sustained a severe loss in the death of Mr. John Somerville. It was felt by the Committee that it would be better if some steps were at once taken to convey to Mrs. Somerville the deep regret with which they heard of her husband's decease, instead of waiting for the present meeting. The Committee were immediately called together; and a vote of condolence was passed and forwarded to Mrs. Somerville, who had acknowledged it. He now asked the members to confirm the action of the Committee in this respect.

This was done without further remark.

THANKS TO THE EX-PRESIDENT.

The PRESIDENT then proposed a vote of thanks to the Past-President for the manner in which he had discharged the duties of his office.

Mr. W. H. H. BROADBERRY (Tottenham) seconded the motion, and it was carried by acclamation.

Mr. DOUGALL briefly thanked the members for their cordial recognition of his services.

NEW MEMBERS.

Mr. C. S. Ellery, of Bath, and Mr. W. Owen, of Horley, were elected members of the Association.

The PRESIDENT then read the following

INAUGURAL ADDRESS.

First let me thank you for your graceful tribute to the Company with which I have the honour to be associated in choosing, for a third time, a President from its officials. Indeed, I cannot but feel that it is to its untiring efforts in the advancement of the great industry with which we are all connected, rather than to my own small labours, that I owe the honour of occupying your presidential chair to-day. Be this, however, as it may, and

since I must necessarily lack those attributes of position and experience which my predecessors have enjoyed, let me ask you all the more earnestly to lend me your cordial aid, that the present year of the Association's work may be not less successful than has been its past.

Foremost among those who have contributed to this success, the name of John Somerville will ever be gratefully remembered. Since our last meeting he has gone, alas! from among our midst, to that undiscovered country from whose bourne no traveller returns. Of us who sorrow at his loss, to some he was a helpful colleague, and to all a friend whose stores of knowledge and experience were ever open to our wants. May he rest in peace!

It has been with me a matter of some little difficulty to choose what, to borrow a German expression, I will call the *motif* for my address. It is not in my power to give you such a treat of ripe wisdom as it has been my own lot to sit and enjoy from the lips of some who have gone before me in this position. I therefore propose shortly to glance at some of those matters in which the records of 1892 show progress to have been made, to touch upon one or two points affecting the still vexed question of purification, and, finally, to say a word of reference to some of the work this Association has contributed, pointing out the great extent of problems that yet remain unsolved, and the most promising direction in which improvement may be sought.

If it can be said of any one subject more than another that it has been largely occupying the attention of gas engineers, this may be truthfully stated of carbonizing. In most other directions, progress has been effected on certain well-defined lines; the difficulty being for the great part either of mechanics or of policy, and thus permitting an easy stating of *pros* and *cons*. But the use of sloping retorts, though not exactly involving the turning upside-down of our retort-houses, yet goes sufficiently far in that direction to make the consideration of their claims a very serious matter. Let us at the outset state the problem to be solved. This is simply, "How can we most economically carbonize our coal?" Now carbonizing coal does not consist in putting coal into a retort, and, after a given time, drawing out what is left behind of it. There is a chemical as well as a mechanical efficiency to be reached; and these unfortunately lie in opposite directions. Mass, which fills with joy the heart of the engineer, is an equal sorrow to the chemist. The one would like a retort taking, say, 100 tons at a charge; the other, a 100-grain sample in a combustion-tube. How nearly can these two antagonisms be brought into line? Well, in whatever ideal

carbonizing may consist, a near approach thereto will, I believe, be found in operating upon a layer of coal as thin as possible, as even as possible, and with as regular a degree of heat as possible. The statement of these conditions is not new. It has, in essence, been made before, I believe, by the occupant of this chair; but I lay stress on them now because there seems great danger of their being overlooked.

Be it remembered that the products of the distillation of coal are not of uniform, but of very varying, composition from beginning to end of the operation. In a paper read before you by Mr. Folkard in 1887, he stated that so deleterious indeed to luminosity was the gas given off at the tail-end of the charge, that not zero, but a high *minus* quantity must be assigned to it. His careful experiments are weekly confirmed by most of us who stop working on Sundays; for we know that the mixture of the Sunday morning and Sunday night gas requires extra enrichment to produce a quality equal to the daily average. To better explain the bearing of this in relation to ideal carbonizing, I will take, as an example, another operation with which you are familiar—viz., the action of a lime purifier into which gas containing carbonic acid is passing. After a time, carbonic acid shows on its outlet; and if, on account of its prejudicial effect on the illuminating power, all traces had to be kept out of our finished gas, we should have to put to work another purifier. When this happens, however, would the lime have become completely carbonated? Certainly not. A large proportion would still be existing as virgin lime, simultaneously with the free passing of carbonic acid. The reason of this is, as you well understand, that the lime is not uniform in texture or closeness —that is, in its physical condition as it rests upon the sieves; one portion offering less resistance or less affinity to the gas than another.

Now, mark the analogy. What happens in ninety-nine out of a hundred lime purifiers, happens to the charge of coal in a retort. At a time when a gas, valuable in illuminating constituents, is still being evolved from the thicker or closer portions of the coal, it is being polluted, so to speak, by that coming from other and spent parts, just as with our lime purifier the carbonic acid got forward from the purifier, while a considerable margin of efficiency still remained with the material. If, however, the process of carbonizing be made to conform with the conditions I have laid down—that is, if the coal is of even texture, in an even layer, and uniformly heated, the change from a *plus* through zero to a *minus* quantity of

illuminating power occurs simultaneously throughout the entire volume of evolved gas, and permits the charge to be drawn at the proper instant, with a resultant minimum of waste.

Here, then, is laid down one standard by which we may measure the efficiency of any system of carbonizing we may be called upon to examine. Do those involving the use of horizontal or of sloping retorts equally comply with it? Well, I am bound to admit that I have not yet seen any system of inclined retorts in which this condition is met as satisfactorily as it is with scoop-charged horizontal retorts. But we must be careful not to condemn sloping retorts on this account; for, on the other hand, they may possess other advantages more than counterbalancing any loss in what we will call coal efficiency, or, indeed, means may be suggested whereby this too may be avoided. One of our most practical carbonizers realized the importance of this difficulty, and made a very notable attempt to overcome it. I refer to the invention by Mr. G. C. Trewby of his charging-plate, the mechanism and use of which is fully described and illustrated in the Transactions of the Institution of Gas Engineers for 1891. But, however successful it may be in accomplishing its object, we must not forget that it entails the re-instatement of machinery in the retort-house, which the advocates of sloping retorts proposed wholly to displace.

Before leaving chemical for mechanical considerations in our comparisons, I would say just one word on what we will call a physical matter, forming, as it were, a link between them. I allude to the difficulties attending the heating of sloping as against horizontal retorts. However troublesome these difficulties may have been, I do not look upon them as insuperable or, indeed, serious. It would not be possible to say of a good many settings of horizontal retorts that they were regularly and evenly heated; and I think it will be found that similar causes are existent in either case. I believe I was one of the first to point out, in a paper read before The Gas Institute in 1888, that the composition of the gases coming therefrom varied at different parts of the producer, and that, as these were also of unequal temperature, good results could only be obtained by allowing them to mix before they were admitted to the setting. I also showed how a non-appreciation of this had led some designers to reduce the size of the nostrils as these receded from the furnace. A common fault, too, was to make the combined area of these so great that there were not sufficient gases to distribute themselves over the whole of them. With sloping retort-settings, on account of the greater ascension of the gases,

he more the nostrils rise in level the smaller should be their area; and if the mistake of making them too large at the outset were avoided, it should not be difficult to experimentally determine the proper dimensions, and fix them once for all.

There now remains to be considered the mechanical efficiency of the two systems; and these we may conveniently subdivide into labour and wear and tear charges. At London prices, carbonizing wages may be assumed as 3s. per ton for horizontal hand charging, as against 1s. 6d. per ton for sloping retorts. But that the comparison should be fair, it must be made as between machinery, instead of hand stoking. This has been at various times differently stated, but would certainly not exceed 1s. 6d. per ton carbonized. So, therefore, our first equation resolves itself into interest on outlay and wear and tear of machinery, as against interest on outlay and wear and tear of sloping over and above that chargeable to horizontal retorts. Our thoughts are thus impelled towards the consideration of what forms of machinery are at present available for working horizontal retorts. Of the many contrivances which have been suggested for this purpose, two systems appeal strongly to our notice—the hydraulic machinery of Mr. Foulis, and the compressed air machinery of our Past-President, Mr. West. Fortunately, these gentlemen are of wide experience as gas engineers; and their friendly rivalry cannot fail to be of service to our industry. Apart from their motive power, the two systems have no resemblance to one another; and an examination of their synthesis is an interesting one. It is the practice in the North to charge cannel coal with the shovel; while in the South, the scoop is pretty generally used for caking coal. The Foulis (or rather the Foulis-Arrol) charger reproduces, in a sense, the action of the shovel, in that each charge of coal is pushed in successive portions into the retort; the pusher (a sort of rake) shortening automatically, until the operation of charging is complete.* In the latest and most improved form of the West machinery, a scoop is used holding 2 cwt. of coal; two constituting a charge. I have lately had an opportunity of inspecting, at the Old Kent Road works, this, the latest, evidence of Mr. West's persistent efforts; and I am bound to admit that no installation of retort-stoking machinery I have yet seen has pleased me so much as did this one. Mr. West has greatly improved not only the efficiency of his machines, but also that of his air-compressing engines, and with extremely satisfactory

* An illustrated description of the Foulis-Arrol charger will be found in the *Journal of Gas Lighting*, Vol. LX., p. 555.

results. In fact, the whole of the plant is well worthy of a visit by all interested in this important question. In the above comparisons, I have made no mention of the rake or drawing machine, as the designing of this does not present very great difficulties to the engineer.

In 1886 I had the honour of making my first appearance before this Association, as the reader of a paper on a new system of retort heating; and it is a curious circumstance (which it may not perhaps be out of place to mention) that, in my present year of office, these identical retorts will be re-set, after an average life of over 1800 working days. As regards the cost of attending to the furnaces, the 8-hour movement has since intervened; but it may be interesting, for the purpose of comparison with the figures originally given, to state that this charge is now, for a house of 180 through retorts, 18s. 9d. a day of 24 hours for fireman's wages, *plus* 10s. for cleaning out the ash-pans.

Following in importance the year's progress in retort-house machinery, comes the large substitution of oil for cannel as a means of enriching coal gas. Undoubtedly, the simplest of the various methods which have been proposed for doing this is the Clark-Maxim process, in which light petroleum spirit (of about ·680 specific gravity) is vaporized under pressure, afterwards mixing automatically with the stream of ordinary gas. The question frequently asked in reference to the process is, "Does the vapour travel?" In my own case, the works' photometer and that at the testing-station do not give the same results by, as nearly as may be, 1 candle. But this difference is the same in midwinter as at midsummer; while the jet photometer gives identical results in both cases. If further proof were necessary as to the stability of the vapour, there remains the fact that but little is found in the syphons between the testing office and the works, though these are two miles apart.

More interesting still, however, is the advent in London of carburetted water gas, already used extensively in the United States, and now being made on a large scale by The Gaslight and Coke Company. Its use does not, however, appear to be attended with the extent of success which was first expected of it; an important governing factor being the cost of oil. It was hoped that crude oil could have been used for the purpose of carburetting. But repeated experiments have resulted in failures; and recourse has had to be made to refined Russian oil, known as "Solar Distillate." The Springer plant erected at the Old Kent Road works was designed to overcome this difficulty, by vapourizing crude oil in separate retorts, afterwards passin

these vapours into the carburetter. The process has, however, not turned out a success; and the only plant now being operated in London upon a large scale is that known as the "Improved Lowe." Whatever possibility there may be in the future for the use of water gas, it is at present an open question whether it is of much greater value than as a ready means of raising 16-candle coal gas up to the 17 candles now found necessary in order to meet the requirements of official testing.

I cannot refrain from here adding my plaint to what we will call the "bitter cry" of the London gas engineer on this testing question. None but he knows what it means; and he must often sigh for the peace and comfort the control would give of such an undertaking as one of the largest Corporations in the North, whose Gas Examiner has recently reported that over 52 per cent. of the total year's tests were below the standard of illuminating power. Before quitting the subject of water gas, you will be pleased to hear that our friend Professor Lewes has been busily engaged upon a new process of his own, which bids fair to be a great improvement on present methods, and which is not less interesting as being the result of his patient and laborious investigations into the most economical means of using oil, with much of which work you are familiar through his published utterances upon the subject.

There still remains a third method of enrichment—the use of oil gas; and no less an authority than Mr. W. Foulis has stated reasons for his belief that this method will be found to give the most satisfactory results of all. For further extension of our knowledge on this point, we shall doubtless be chiefly indebted to our *confrères* in the North, who are the more concerned therein, since their standard of illuminating power is considerably higher than ours. Especial interest will attach to the process of Mr. W. Young, as carried out by him at Peebles, and who appears, by what we may call the persistent distillation of the oil, to split it wholly up into hydrocarbon vapour or gas and free carbon, which is left behind in the retort in the form of a saleable coke.*

Reference to the enrichment of coal gas would be incomplete without some allusion to a knotty problem which has vexed a good many minds, and is, it appears, still far from solution—viz., What is the most suitable quality to take as the standard for illuminating gas? For it must be remembered that, since these were settled in the earlier days of the gas industry, the

* An account of Mr. Young's process was given in the *Journal of Gas Lighting*, Vol. LX., p. 860.

conditions of supply have radically changed. Gas is no longer distributed solely for consumption in union or batswing burners for light-giving purposes; but also for cooking and heating, for motive power, for use in regenerative lamps, and as Bunsen flames within the mantles of the still more economical Welsbach burner. It may be taken as certain that the scientists' dream of a dual supply of heating and lighting gas is beyond the sphere of practical possibility; and it is therefore necessary to arrive at an average between the extremes of non-luminous heating gas and (say) 30-candle illuminating gas, at which the consumer can be supplied with the greatest economy to him. I am strongly of opinion that this result is not represented by the quality it has now become necessary to supply in London, and that, for the money spent by the consumer in enriching material, he does not get a proportionate advantage. May I here throw out the suggestion that a paper on the subject would form a very good text for discussion at one of our November meetings?

As the engineering achievement of the year must undoubtedly be ranked the East Greenwich holder; the successful working of which throughout the past winter having triumphantly vindicated the boldness and originality of its design. Of especial interest was the safe cupping and uncupping of the inner lift, the proportions of which are, as graphically stated by Mr. Livesey, those of the thickness of two penny pieces compared with their diameter. This result has been ensured by making the guide-rollers a combination of the radial and tangential types, and by taking means to ensure their always being kept tightly up to their work. In the first gasholder for which I was inspector, it was laid down for my guidance that, in adjusting the inner rollers, space equal to the double thickness of a wooden rule was to be left between them and the channel-iron roller-path. It is quite likely that this open practice, coupled with the not uncommon want of rigidity in the bottom curb, had something to do with those early failures which led to the formulation of the rule contained in the text-books as to the relative proportions of the diameter and depth of gasholder lifts. The advantage of large holders as affording a cheap means of meeting the ever-increasing demands upon storeage capacity, were cogently stated by Mr. Livesey in describing this holder at the meeting of the Institution of Gas Engineers last May; and as the paper was very fully and completely illustrated, I must refer you to it for the details of what is, in truth, a monumental work. It is, however, known to most of you that two lifts go out beyond the

framing. But from this it must not be presumed that this indicates any approach in Mr. Livesey's practice to the abolition of guide-framing. On the contrary, he himself has pointed out, in a letter to the *Journal of Gas Lighting* [Nov. 29, 1892], that these two lifts form but one-third of the total height of the holder, and beyond which he does not consider it expedient to go. I think the large majority of engineers will wholly agree with him, and that, although the system of guiding a holder from the base is delightfully ingenious, its application is only possible to holders on a very much smaller scale indeed.

No reference to the past year's teachings would be complete without mention of the disastrous explosions which have occurred in liquor and tar wells. Familiarity with danger breeds, in most cases, a contempt of it; and this becomes reprehensible if coupled with it is neglect of any and every possible precaution against accident. The presence of explosive mixtures in tar and liquor wells is easily accounted for, without any abstruse theory, by the crude gas which is carried forward mechanically through the seal cups, and by sulphuretted hydrogen evolved from the liquor. Efficient ventilation is probably the best and only safeguard; but, in carrying this out, care must be taken that no loss of ammonia, &c., ensues. I find this is easily done by placing small scrubbers (formed out of 18-inch pipe, and filled with coke) in connection with one or more of the tar and liquor wells. The top of this pipe is carried up out of harm's way; and its contents are kept constantly wetted with fresh water from an automatic syphon discharge. I have long looked with suspicion on the ordinary so-called safety-lamps of plate glass and gauze, as something of a danger trap, and have now almost wholly displaced them by electric hand-lamps. The incandescent carbon of these is protected by two glass globes, and is so arranged that, if the outer one of these is fractured, the lamp is automatically cut out of circuit. All possibility of sparking is eliminated by using a self-contained primary battery of zinc and carbon couples to produce the current.

The increased attention given to the problems involved in purification may be taken as a sign of the times, that engineers are looking more closely than ever into every detail of gas manufacture; and purification cannot be considered an unimportant one. One of our Past-Presidents, Mr. May, has already dealt very ably with this subject in the address he delivered before you three years ago; and in a paper which I had the honour of reading before you at our last meeting, I gave some

results which were obtained on a large scale at Vauxhall. And though the two busy winter months afforded little leisure for investigations, yet I should not like to omit from this address one or two points of interest, although no opportunity is here afforded of their being discussed. A few words may not be out of place as to the desirability or otherwise of removing sulphur compounds. Excluding capital charges, we may take the cost of purification in London at (say) ¾d. per 1000 cubic feet for materials and labour. Now, concurrent with sulphur elimination is that of carbonic acid. Taking the original volume of this at 1½ per cent. of the scrubbed gas, the depreciation in illuminating power due to its presence in that quantity would be about ¾ candle. The cost of enriching 1000 cubic feet of common gas by 1 candle has been variously stated by several investigators. But taking 1½d. as the minimum would give 1⅛d. per 1000 cubic feet as the value of the increase in illuminating power due to the extraction of the carbonic acid, from which, however, must be deducted, as before stated, the capital charge due to increased plant over and above that required for oxide.

I will now give you a few details of the results obtained when working lime purifiers in the way I described to you last November. This, you will remember, consisted in part of putting a known percentage of air into the fourth or third vessel of a rotation set. We have since been able to go a step farther. At the time when a clean lime vessel is put on, we are passing large quantities of sulphuretted hydrogen into the oxide vessels. Air, too, is put in at the stated rate. But after about 24 or 36 hours it is shut off, and appears to be not again necessary. Should this, our present experience, be borne out in continued practice, further advantage will be gained from the greatly reduced average quantity of air required to bring about the reactions. But the criterion of effectiveness in any system must be based upon the composition of the material rejected from the purifiers as spent lime. We are able to work up to 80 per cent. of carbonate of lime in our waste, which also contains from 8 to 10 per cent. of free sulphur. The latter is, of course, valueless, and a dead loss. It should all have been deposited in the oxide of iron purifiers; for I affirm that ideal working would not be to get as much sulphur as possible into the lime, but at least only that existing as bisulphide of carbon, the remainder of the lime saturated with carbonic acid, and the whole of the sulphuretted hydrogen driven forward into the oxide of iron, whence it can be more profitably extracted. The analysis I have given shows that progress is

being made towards the goal defined. Moreover, lime purification, carried on as described, is productive of few, if any, more difficulties, as regards smell, than are attendant on the discharging of an oxide box. The spent lime is of a greyish-blue colour; and, excepting that composing the top layer, very dry and friable. The cause of the objectionable wetness of the top tier became matter for further investigation. In a rotation series of four boxes, the gas in two was arranged to flow upwards, and in two downwards; but in either case the top layer was always found to be wet. On reflection, it appeared that the cause was to be found in the water vapour rising from the lutes—a matter of greater importance, as the purifiers are worked at a temperature of between 80° and 90° Fahr. The lutes were then covered with oil in sufficient depth to prevent any loss of water. The same plan has also been adopted with the oxide of iron and Weldon mud vessels, with, so far, very satisfactory effect. Do the above-enumerated results leave any margin of advantage for the substitution for air of pure oxygen? I venture to think not, and that chemical reasons are but confirmatory. I have elsewhere directed attention to the importance of temperature to the reactions involved in purification. If a stream of carbonic acid gas be passed into a small bulb containing slaked lime, the heat of combination is such as to rapidly raise the temperature from normal to over 150°; and when sulphuretted hydrogen is passed into oxide of iron or Weldon mud, the action is even more energetic. Professor Dewar has found that, at low temperatures, chemical action ceases between substances having normally great affinity for each other. Is not all this presumptive evidence in favour of so protecting the vessels in which the reactions called "purification" occur that their temperatures may be wholly under control, and protection afforded from the rigours of our climate? I shall not, indeed, be surprised if further investigations do not result in finding 150° a better working temperature than 50°.

It seems probable that we are at last within reasonable distance of possessing a real standard of light for photometrical purposes. Being impressed with the extremely unsatisfactory character of the present one, the South Metropolitan Gas Company, which is nothing if not progressive, offered to pay the whole costs of an inquiry by a Committee of experts into how might best be replaced by a more exact and reliable one. This Committee is now sitting; and it is no secret that its investigations are being made as exhaustively and thoroughly as can be imagined. But there are circumstances of great interest to be

related as to the part this Association has played in bringing about the solution of this long-deferred problem. I refer to that most able paper on "Photometry," read before you by our friend and Past-President, Mr. Methven—a memorial of such persevering and painstaking labour as few Associations can number among their records.* So impressed, indeed, were the Council of the Institution of Gas Engineers with the value and importance of Mr. Methven's researches, that at its meeting in May last a resolution was carried, and afterwards forwarded to the Board of Trade Standards Committee, asking that the Institution should be heard before any conclusions were come to. This request—the first step taken by any Institution to place itself in touch with the Committee—was courteously received; and, as a result, the Council drew up certain recommendations, which, as they have since been prematurely published, there can be no harm in detailing. They are as follows: "That attention be drawn to Mr. Methven's experiments showing the influence of the hygrometric condition of the atmosphere upon the pentane standard of light; correction for that source of error appearing to be necessary to enable the pentane candle to be used for standardizing." "That air carburetted with pentane be used for testing purposes." "That a multiple of the standard candle equal to 10 candles be produced for testing purposes by the application of a screen to an Argand burner; and that all tests be performed with an open bar photometer not less than 60 inches in length." "That the rate of consumption of the gas to be tested be adjusted as nearly as practicable to the maximum efficiency of the various standard burners." Now, if you will refer to Mr. Methven's paper, you will notice how largely the above recommendations were based upon it; and, further than this, I may say there is reason to believe that the experiments made to verify their accuracy, under the direction of the Standards Committee, have more than borne them out. So, gentlemen, I think you will agree with me that this Association may well be proud of having been the means of bringing prominently under the notice of the gas industry this important question; and I am sure the Institution ought to be exceedingly grateful for having such valuable material ready to its hands.

I cannot here refrain from quoting from a paper read last year before the American Gaslight Association by Mr. W. R. Addicks. In it he points out the advantages which would accrue to the gas industry as a whole by the federation of its

* See "Reports of Gas Associations" for 1889, p. 356.

various Associations. Replying to the question: "What organization would meet this case?" he proceeds as follows: First, a national association, with active members composed of the engineers and managers of gas companies; secondly, district associations, with active members composed of engineers and managers of gas companies in the given districts. Membership in a district association would not necessitate membership in the national association. A journal of proceedings to be published by the national association, but containing also the reports of the district associations. The national association to meet yearly in the spring, when the greater number of members could be present; district associations, three times a year. He goes on to define the composition of the council and committees, and finally directs attention to one or two matters of importance, the co-operative investigation of which would bring about greatly improved results. Gentlemen, the American nation can afford to give us a good many points from a federation point of view; but is it not possible that, as regards an industry which we can call especially our own, we may take the wind out of their sails by bringing about, in our Mother Country, such a federation of gas associations as our American *confrère* has sketched out? It would, I heartily and earnestly feel, be a good thing for all if the Year of Grace 1893 should witness the bringing about of a consummation so devoutly to be wished.

Now, gentlemen, before bringing this address to a close, I must not forget that presidential crotchet without which none would be complete. My own especial one will take the form of an earnest plea for the larger inclusion in the daily routine of gas manufacture, of experimental work in connection with the chemical aspects of the problems involved therein. Let us not take for granted that our present systems and methods are perfection, and spend the whole of our time in devising mechanical improvements in carrying them out. Let us probe them to their very bottom, and ask ourselves whether, for instance, our present system of carbonizing coal is chemically correct or radically wrong; whether, in its present form, it may be vastly improved; or whether there is justification for the belief that our conceptions of it are erroneous, and must be formed *de novo*. The chemist can never take the place of the engineer. But while I strongly hold that some real chemical training is an important advantage to the latter, yet the chemist should have to him the same relationship, and hold the same position of importance, as does his assistant or his draughtsman. Look at the part the

spectroscope has played in some of the important industries of the country—I will take two dissimilar ones—steel making and sugar refining. Can this instrument not be brought into our service? Could we not make the collection of the gases evolved in carbonizing coal a selective one; retaining what is good, and abrogating what is bad to heat our boilers and drive our engines? Or, to come more nearly to the pounds, shillings, and pence aspect, how many among us buy our lime in terms of CaO, and pay on the composition of each sample? or buy our coal on the basis of pounds of sperm, and see that we get what we pay for? or see that our waste lime deserves the appellation of "spent," and does not consist of half unused hydrate? These are but one or two among the many questions to be dealt with, if the potentialities of gas manufacture are to be fully opened up.

Whether the science of modern chemistry owes its inception to Cavendish or Lavoisier will perhaps ever remain a debateable point. There is none as to the origin of our own great industry. And since it is to our countryman William Murdoch, that all the honour of this is due, should not our persistent efforts be directed to maintaining that unquestioned supremacy? The result can only be obtained by every one of us, each in his own sphere, working steadily onward with the great goal in view; and that this Association may win its share of the laurels is the hope which inspires our efforts to make even greater the proud position it holds to-day.

Mr. C. E. BOTLEY proposed a vote of thanks to the President for his address.

Mr. W. D. CHILD (Romford) seconded the proposition, which was unanimously agreed to.

The PRESIDENT briefly expressed his thanks to the members for the hearty manner in which they had received his address.

PRESENTATION TO MR. HELPS.

The PRESIDENT said it was now his rare good fortune to have to perform the most pleasing duty that it was probable would ever fall to his lot, and certainly the most pleasing duty that could ever fall to the lot of any President of the Southern District Association. Presidents came and Presidents went, but the Secretary stopped with them (he was about to say) for ever. At any rate whether or not that was so, he undoubtedly was the mainspring which kept the Association going in the manner it did; and by a similar analogy, they might look upon the President for the year as being the key which for that period wound him

up. The presentation he was about to make to Mr. Helps, he was quite aware, was not the highest it had been his lot to receive. He had probably had in the past other testimonials of his excellent qualities which he might be pardoned for valuing more than the one he (the President) was going to hand to him; and yet he thought he could truthfully say that no presentation could be given with more heart—he thought he could almost add, with more love—from a body of men to another than this he was going to make to Mr. Helps. It had taken the form of a handsome gold chronometer; and the inscription on it was as follows: "Presented to Mr. J. W. Helps, by the Southern District Association of Gas Engineers and Managers, in grateful recognition of his services as Honorary Secretary—February, 1893." Handing the watch to Mr. Helps, the President said: I have great pleasure, on the part of the members of this Association, in presenting you with this watch, which is but a poor recognition of the value in which they hold your services as Secretary.

Mr. HELPS, in acknowledging the gift, said, as no doubt most of the members could imagine, his position at that moment was a very trying one. He was surprised at receiving such a testimonial, because he felt that, for many reasons, it was not deserved, seeing the short time (only about six years) he had acted as Secretary of the Association; and the light—he might say pleasurable—nature of the duties he had to perform did not appear to him to warrant any such recognition at the hands of the members. But he could sincerely say that he most thoroughly appreciated the manner in which, whatever his services had been, the members had recognized them. The President had said that he had probably received in his life testimonials which he valued more than the present one; but in saying this, he had said something which he (Mr. Helps) did not feel was true. He had never had anything given to him which, he was sure, he should always look upon with so much pride, and which would bring back to him such pleasurable memories, as the watch he had received that day, and for which he thanked the members one and all most heartily.

This concluded the business portion of the proceedings; and the members afterwards dined together.

MIDLAND ASSOCIATION.

ANNUAL MEETING, FEB. 16.

This Meeting was held at the Grand Hotel, Birmingham—Mr. B. W. SMITH, of Smethwick (the President), in the chair.

The minutes of the previous meeting were read by the HON. SECRETARY (Mr. C. Meiklejohn, of Rugby), and confirmed.

COMMITTEE'S ANNUAL REPORT.

The annual report of the Committee (which was accompanied by the statement of accounts for the year ended Dec. 31, 1892) was then presented, as follows :—

The Committee have pleasure in submitting the following report for 1892.

The annual meeting was held in the Grand Hotel, Birmingham, on Thursday, March 10. Owing to the indisposition of the President (Mr. W. Littlewood), who wired his inability to be present, the chair was taken by Mr. R. O. Paterson, of Cheltenham. As the President's address was necessarily postponed, no business other than of a routine nature was brought before the meeting. As soon as the latter was disposed of, the meeting was adjourned till 2.30 p.m., when the members were driven to the works of Messrs. Piggott and Co., Hooper Street, Spring Hill, Birmingham, for the purpose of seeing the Sutherland arrangement of water-gas plant there, and of witnessing the application of the gas for welding wrought-iron tubes, sugar-pans, &c. The members were very courteously received by Mr. Lloyd, who, with several assistants, conducted them over the works.

The spring meeting was held in Rugby, on the invitation of Mr. Peter Simpson, whose Directors kindly granted the use of the Board-room for the purpose. In the unavoidable absence of the Chairman of the Company (Mr. Parnell), Mr. Lawrence, the Vice-Chairman, together with the Secretary, Mr. Wratislaw, and Mr. Simpson, the Manager, gave the members a hearty welcome. After the disposal of the usual business, the President (Mr. Littlewood) delivered his Inaugural Address, dealing in a very practical and interesting manner with the chief topics of present-day management, the abnormal price of coal, the labour problem and profit-sharing, the standards of light, and carburetting with oil. On the conclusion of the President's Address, a paper was read by Mr. Hutchings on "The Monier Construction System," in the discussion of which several members took

part. The members subsequently visited the famous Rugby Schools and Chapel; and, in conveyances provided by Mr. Simpson, enjoyed a drive of two hours through the charming country in the neighbourhood. On returning from the drive, the members were divided into two parties to visit the works of the Rugby Cement Company and the Newbold Cement Company, where the manufacture of Portland cement was shown, from the quarrying of the stone to the finished product. On the invitation of Mr. Simpson, the members then dined together in the Board-room of the Gas Company; thus bringing to a close a very enjoyable, and one of the best attended, meetings of the Association.

The autumn general meeting was held in the Grand Hotel, Birmingham, on the 27th of October—the President (Mr. Littlewood) in the chair. The discussion of Mr. Hack's paper on "Elliott's Process of Continuous Carbonizing," read at the October meeting in 1891, and which had been repeatedly postponed to enable the Committee appointed last year to report, was then taken; no opportunity having been afforded the Committee to visit the works or to examine the process at Ludlow. Considering the time that had elapsed since the paper was read, the discussion was interesting and well sustained. A practical and well-written paper by Mr. T. B. Jones, of Willenhall, on "Stopped Ascension-Pipes: Their Cause and Cure"—the latter being the insertion of a perforated drum or cylinder of Mr. Jones's invention—led to a good and animated discussion. The following officers were unanimously elected: President, Mr. B. W. Smith, Smethwick; Honorary Treasurer, Mr. Peter Simpson, Rugby; Honorary Secretary, Mr. C. Meiklejohn, Rugby; Auditors, Mr. C. Dakin, Cradley, and Mr. J. Brooks, Derby; Committee: Messrs. Hulse and Belton were elected to succeed Messrs. Hunt and Reeves, who retired. A very interesting part of this meeting was the presentation of a silver salver and antique cup, with an illuminated address, to Mr. Peter Simpson, on his retirement from active work, as a mark of the esteem in which he is held by the members of the Association, and in recognition of his very valued services as Honorary Treasurer of the Association for eleven years. The presentation was made by Mr. Charles Hunt, and very feelingly acknowledged by Mr. Simpson.

On behalf of the Committee,

B. W. Smith, President.

C. Meiklejohn, Hon. Secretary.

Mr. J. T. Lewis (Wellingborough) moved the adoption of the report and accounts.

Mr. J. S. Reeves (Bilston) seconded the motion; and it was carried.

Alteration of Rules.

On the motion of Mr. W. Littlewood (West Bromwich) seconded by Mr. W. T. Tew (Warwick), an alteration was made in the rules, so as to constitute the Vice-President a member of

the Committee, and make him responsible for conducting the proceedings in the absence of the President.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—The position of President of such an important Association as ours is not an easy one, so far as regards finding suitable subjects upon which to give an address. Although time and science have both caused such rapid strides in the development of our business, nearly every detail has been so well thrashed out—either by previous addresses or by the papers which have been from time to time kindly given to, and well discussed by, this and other Associations—that it really becomes year by year a more difficult task to introduce anything fresh to impart to others.

The past year has been one of considerable anxiety to most of us. The excessive high price of coal and the low price obtained for residuals have hampered our results; and were it not for the continued increase in the demand for gas, the look-out would not be a bright one. It has no doubt been the means of sharpening our sense of economy, especially as the value of retort-house labour seemed to go up in conjunction with the rise of coal and the fall in the price received for residuals. On looking back for the past ten years, I find we are now paying 31 per cent. more for our coal; and although we have received about the same for coke, tar has fallen in value 56·69 per cent., ammoniacal liquor 64·48 per cent., and spent oxide 60 per cent., whilst retort-house wages have increased about 20 per cent. Perhaps these adverse circumstances have in a measure been for our good, inasmuch as they have led many to exercise extra vigilance in the improvement of their works, and not remain content to jog along in the old humdrum style, so long as the usual dividend or profit was forthcoming. I wish therefore to bring before your notice a few important points where economy has been, and still can be, effected in many of our works.

The handling of coal, in stacking, relifting, and conveying to the retort-house, is always a heavy item; but I think it will eventually be met by the introduction of conveyors or aerial ropeways. The former have already been adopted in some works with much advantage; but it has only been done in conjunction with other machinery. The vast improvements which have been made during the past few years in the various systems for heating the retorts on the most economical principle—whereby the fuel account alone can be reduced from 40 to 11 per cent., and even to as low as 10 per cent., besides

increasing the productive power of the retorts by allowing more frequent and heavier charges, and thereby giving a larger yield per mouthpiece and per ton of coal carbonized—have effected a great saving to many. Of course, much is to be said about the first cost of making the necessary alterations. Still, I feel sure that no one who has been able to persuade his board or committee to sanction the necessary expenditure, need have any fear as to the ultimate results. Inclined retorts are yet in their infancy; but they seem to have been taken up with considerable energy during the past year. Much has been done, and much more will be required before the profession as a body will be satisfied that they are a perfect success. Sufficient time, to my mind, has not yet elapsed for those works where they are in operation to give a decided opinion upon their working. The very considerable outlay in altering the retort-house, and renewing the whole of the pipes and fittings, will doubtless prove a serious obstacle in their way. Stoking machinery of various kinds—manual, steam, hydraulic, and compressed air—either for drawing or charging, has been introduced into many works; and this has no doubt been forced upon them by the strikes and the increase in the wages of the stokers. Supposing, even, that the machines did not reduce the cost of labour, the work is done much more efficiently, and consequently better results are produced.

Much loss and damage to the quantity and quality of the gas is caused by too rapid condensation; and in corroboration of this, I may say that, in making the alterations I have recently done at my works, I have had a good opportunity of ascertaining the great disadvantage of cooling the gas too rapidly—having had to allow it to go practically direct from the collecting-main to the condensers, where it has entered as high as 148° Fahr. I consider that, in so doing, I have lost quite half a candle of illuminating power, besides diminishing the yield of gas. However, as soon as the winter has passed, I shall lose no time in completing the work, and altering this state of affairs. I have taken this opportunity of mentioning the matter, to put others on their guard in case they are working in this way. Many who work with a hydraulic main have too deep a seal; and I believe much loss is incurred through that. The less you can work with, the greater the amount of freedom for the gas, besides diminishing the work for the exhauster, and in a measure preventing stopped-pipes and the pitching-up of the pipes. I have recently abandoned the hydraulic main, and now work with a throttle-valve to each H-pipe, which

is connected to a dry main; and I must say I find very considerable advantage from the change. The temperature of the gas at the inlet and outlet of the condensers should be carefully watched, so that excessive changes do not take place. Sufficient attention is often not given to ascertain whether the washer or scrubber is really doing its duty; and to see that ammonia does not pass on to the purifiers, where it becomes of no commercial value. Although much improvement has lately been made in the various apparatus for extracting the ammonia in the gas, there are no doubt some works where this impurity is given a secondary consideration. Loss is often incurred by the mode of dealing with the ammoniacal liquor. Where carriage forms a serious item in the disposal of it, sulphate plant for working it up should be put down, as the saving would be found considerable. If otherwise disposed of, great care should be exercised in making contracts. The old system still much in vogue, of selling by degrees Twaddel, is much like its name. I have had a deal of experience in the various methods of testing; and have no hesitation in advising all who can to test and sell their liquor by the distillation test, which gives the absolute amount of ammonia it contains, and is more equitable to all parties concerned.

Although tar is not fetching the price that it did, I fear we are not as careful to collect all we make and to store it in the proper place provided for its reception—syphon-pots are allowed to overflow, and proper apparatus for arresting its progress to the purifiers omitted. These are little matters, but well worthy of attention.

Good purification is very important; and forms a fair item in many works, depending largely upon the method adopted. Much controversy and correspondence has taken place upon the subject. In some cases oxide only has been used; whilst in others all lime, or lime and oxide, and oxide and lime. The atter I consider the best and most economical, if you have no restrictions placed upon you. The admission of oxygen to the gas before entering the purifiers, appears to have met with considerable favour in many quarters; although the old process of allowing a small percentage of air is still much in use. When oxygen can be produced at a cheaper rate, I have little fear but that its use will become very general; for anything that will lessen the cost of labour, and save the loss of gas and the nuisance when changing material in the boxes, will be hailed as a boon by one and all of us. Until then, it is very necessary to select the best materia of its kind—either oxide or lime; and in

the case of the latter, great care should always be taken that it is properly slaked and well cooled down before it is used.

In every works, we have to generate steam for our engines, pumps, and other apparatus. The question has often arisen in my mind whether we are as careful as we should be to ascertain if our engines are working efficiently. Perhaps we should find, on their being tested, that we are wasting steam, and so causing a loss in fuel and water. I have effected an enormous saving by utilizing the breeze dust under my boilers with a forced draught. Since I made the alteration over two years ago, I have not used a pound of slack, coke, or breeze. There are others who have effected a like economy, and many more might do so; for if they do not produce sufficient breeze dust, then they can burn up the ashes which come from the furnaces, provided they first pick out the largest of the clinkers.

The leakage account always forms a source of worry to many, especially those in whose districts mining operations have been or are taking place; but where no such disturbances occur, there is no reason why the unaccounted-for gas should be as high as it is. We all know that a portion of it lies between the station and consumers' meters, caused by the difference of temperature at the points at which the gas is registered; but how much more is lost by neglected services and meters overworked, would astonish many. Yet there is another source—public lamps. Regulators are allowed to get out of order; and as a rule, I have found that the percentage of large lights predominates. Then the check which is kept upon the time of lighting and extinguishing is often a loose one. I have for some years past had in the centre of each lamplighter's "walk" a meter fixed at the base of one of the columns—taking care to have the regulator checked from time to time; and by the reading of this meter weekly, I have been enabled to check the lamplighters' time by the amount of gas consumed. During the winter months, the pressures should be taken at the various points of the district, with the object of ascertaining if the mains are large enough for the demand, and also to ensure equal distribution and enable the pressure at the station governor to be worked at a minimum; and then we can make any needed alteration in the summer months.

Much more could be done in pushing the sale of cookers and of gas-fires, by encouraging exhibitions and cooking lectures. Like other trades, we must advertise, and bring prominently before the notice of our customers the advantages to be derived by the use of gas cooking and heating appliances; but what we

should study when introducing these appliances is that proper ventilation is taken into account, and not fix them at the risk of having them returned through defects of this kind. I think that the great improvements made in the various kinds of burners now being offered to the public, ought to allay any fear on our part as to the electric light superseding gas.

The development of the gas-engine during the past ten years has made such rapid progress as to greatly affect the question of the employment of suitable motors. By successive improvements in its construction, by various inventors who have closely studied the importance of its future, this motive power has become firmly established in the high position which it now occupies amongst the prime-movers of the nineteenth century. Not only is it acknowledged as reliable for small powers, but it is also largely in demand for sizes of 100 indicated horse power and upwards. As to its efficiency and economy, ample proof is given by the great numbers which are superseding the steam-engine, especially in factories where each department is kept separate, and the motive power is now subdivided. Besides, in many towns, where the space occupied by the boilers has become so valuable, the difficulty of disposing of the ashes, and the risk of fire and boiler explosions have all tended to bring the gas-engine prominently to the front. I am of opinion that it is incumbent upon us, as producers and sellers of gas, to give every assistance in our power to promote the use of these engines; and I feel sure it is only the unfortunate fact of our being at present unable to reduce the price of gas, which prevents their being more generally used.

Through the courtesy of Messrs. Tangyes Limited, who have recently laid down an extensive plant to produce gas-engines on their well-known multiple system, I am able to invit the members to visit their works to-day, where they will have an opportunity of seeing for themselves the enormous business they are doing in this line. They have sent out during last year engines of this type, the total aggregate of which is equal to 5000 indicated horse power; to work and test which with the ordinary coal gas, has necessitated my Committee sanctioning the laying of a special 8-inch main direct from the outlet of the gasholders. The large meter-house they have constructed is ultimately intended for four 800-light and one 400-light wet meters; but for the present two of the larger size only are fixed. These are to be used solely for testing and motive power purposes. Each engine is tested to full power before leaving their works, and consumes from 15 to 24 cubic feet of gas per

indicated horse power per hour, according to size. It is of the utmost importance that the gas should be kept at a perfectly even pressure while testing the large-sized engines. For this purpose, we have fixed, for their special use, an 8-inch station governor in the same house as the town governor; so that we can, at any time when desired, increase or decrease the pressure to their requirements without interfering with the district supply. But Messrs. Tangyes do not stop at this point. Even with the economical results they have obtained, it is difficult, so they say, for engines over 50 indicated horse power to compete with high-class expansion steam-engines, when the price of gas is more than (say) 1s. 6d. per 1000 cubic feet. A cheaper gas has therefore to be produced; and to this end, they have recently erected a large Dowson producer plant, capable of making gas at about one-quarter the thermal value of ordinary coal gas for 200 indicated horse power, produced from anthracite coal or gas coke. They find in practice that 1000 cubic feet of this gas can be generated for 3d., including all charges, with coal at 24s. per ton. It, however, requires about 50 per cent. more coke than coal to give the same results; and as four times the quantity of this gas is necessary, it is equal to coal gas at about 1s. per 1000 cubic feet.

I have also the pleasure of inviting you to inspect the works I have the honour of managing, where, during the past year, I have had to make considerable structural alterations and additions, to increase the productive power; and I thought it would be of some interest, prior to your visit this afternoon, to have a short description of what has been done. The Smethwick Local Board of Health gas undertaking was purchased from the Corporation of Birmingham; and the works, which were designed and built under the direction of Sir Frederick Bramwell, were started by me on Oct. 1, 1881. They were constructed to produce a maximum daily make of about 750,000 cubic feet; but soon after we commenced making gas, it was found that the storeage and purifying power were inadequate, and an additional and larger gasholder and three lime boxes were put down the following year, under the direction of the same Engineer. Since that date, practically nothing was added to the manufacturing plant till last year.

Since 1881 the demand for gas had steadily increased from year to year; and at the close of 1891, it was found absolutely necessary to make further provision for a much larger daily output. After giving the matter most careful consideration as to what could be done—for it really meant either building an

additional retort-house or else altering the interior of the present one—I came to the conclusion that if I adopted Klönne's regenerative furnaces, I should then be in a position to produce a daily make of 1½ millions (besides being able to save the great cost of building a new house), and also work with much greater economy. By the end of February, I received the sanction of my Board to the following scheme: To pull down the present settings, discard the whole of the mouthpieces, pipes, and fittings in connection therewith, and rebuild and fit up with entirely new material. Also to erect an additional condenser for 750,000 cubic feet, an exhauster and engine combined for 60,000 cubic feet, a washer for 750,000 cubic feet, and a station meter for 30,000 cubic feet per hour—the latter having to be fixed in the offices I occupied. New offices had to be built, as well as providing a proper mess-room for the workmen.

The retort-house is 110 feet long by 56 feet wide inside dimensions, having on each side coal-sheds of the same length by 28 feet wide. There were eleven beds with seven retorts to each, 20 feet long by 20 in. by 16 in., Ω-shaped, with an ordinary furnace to each side fired with slack; the main flue running on the top of the bench the full length of the house, connected to two wrought-iron chimneys lined with fire-bricks. Separate hydraulic mains were fitted to each bed, and connected to a 14-inch foul main by 6-inch valves. The gas and tar parted company at the centre of the house—the former passing up a 14-inch main on each side (which ran back half way), and then returning the whole length of the house to the condenser just outside. On account of the delay in obtaining permission to proceed, the alterations were not commenced till May 2; and on Sept. 15 we started to make gas with the first half of the new works.

After building a buttress against the outside wall of the fourth bed of the old settings (four beds being sufficient for the summer months), the whole of the other seven beds were pulled down, the pipes and fittings having been first removed by ourselves. The contractor had then to remove about 8 ft. 6 in. solid cement concrete, which formed the foundation of the old work, and was originally put in on account of the ground to that depth having been made up with ashes. Excavation was then carried on to a sufficient depth and width for the cellars on both sides, and to permit of 3 feet fresh concrete for a foundation for the new works; and where the chimneys came, an additional foot was put in.

The house was then divided into two benches—one with five,

and the other with four beds. Separate chimneys were built at the end of each bench, but not bonded into the other brickwork, allowing of a 5-feet passage way between. The arches of the beds are 9 ft. wide by 17 ft. 3 in. high from the cellar floor. The outside walls are 2 ft. 9 in. thick, composed of hard brown bricks and a 9-inch fire-brick lining. The inner ones are 3 feet thick, including the 9-inch lining; and the piers 18 inches thick, all fire-brick. The arches have two 4½-inch rings, with 4½-inch relieving space, over which is a 4½-inch ring, and levelled up with hard brown bricks. The main flue is built up from the level of the cellar floor, running the length of each bench, and is composed of three 4½-inch rings of fire-work. The tops of the furnaces come up to a level with the retort-house floor, so as to charge with hot coke from the retorts.

The cellars are 8 ft. 6 in. wide by 7 ft. 9 in. high; and the floor overhead is composed of steel rolled joists 3 ft. 6 in. apart, with 4½-inch arches, turned in brick and cement, from girder to girder. They are levelled up with cement concrete; and then paved with hard bricks grouted in cement, having a fall of about 3 inches from the face of the settings, to throw off the water when extinguishing the coke. A drain is provided for contingencies, and runs the whole length of each side of the house, with catch-pits opposite each bed; and in the cellar floor, drains are likewise laid in a similar manner. Air-passages are made in the walls in the centre of each side and at each end of the house, for ventilation and carrying off the steam when cleaning the fires; so that, in whatever direction the wind may be, thorough and perfect ventilation is maintained. This is one of the most important points to be studied when constructing subways. The entrance to the cellar is by an inclined passage at one side of the house, at the bottom of which is an iron gate with a lock, the key of which the fireman alone uses. This, I think, is most desirable, to prevent any unauthorized person tampering with the air-slides or dampers.

The beds consist of eight ⌓ segmental retorts, 22 in. by 16 in. by 20 ft. long, with a 9-inch stop in the centre, fitted up with mouthpieces with patent self-sealing lids, and which are tied in with flange rails secured by cast-iron earpieces and bolted to the steel buckstaves. These are secured by cast-iron shoes bolted to the rolled joists opposite each pier (the thrust being transmitted to the wall of the house), and tied down to their work by a holding-down bolt and plate; the latter being built some feet down in the cellar wall. Each bed has a separate dry main, connected with 10-inch valves to a 14-inch collecting

main at the back; the H-pipes having a throttle-valve to each, and this being worked by the stoker with a hanging rod attached by a hook to the corresponding mouthpiece. Wrought-iron plates are placed on both sides the full length, and up to the underside, of the bottom retorts of each bed, to throw off the water when quenching the coke, and also to prevent the water washing out the joints of the brickwork. I found this very necessary; for soon after we had been at work, the brickwork at this point began to show decided signs of perishing.

The retorts are charged every five hours with 3½ cwt. of coal per mouthpiece; each barrow-load being weighed by the wheeler before it is taken into the house. The machines and barrows are carefully checked morning and evening by the yard foreman. The drawing is done by a manual machine; and the charging, by shovel. When we first started to work, for some little time we had a number of stopped pipes, both in the ascension and H pipe by the throttle-valve, caused by an accumulation of sooty material and pitch—pointing to an excess of heat. The heats were reduced; and the sooty matter disappeared, but pitch still remained. I then had terrifiers made, 5 inches in diameter; and kept a man during the day cleaning out the pipe at the outlet of the mouthpiece. After a short time, the pipes got clear; and since then we have seldom had any trouble. This clearly proves to me, that stopped pipes are mainly due to not keeping the outlet of the mouthpieces clean, using too small terrifiers, and not using them frequently enough. The make of gas is very much more uniform than by the old process. The exhauster works at one-tenth vacuum, which is about the same in the retorts; and the register-gauge gives practically a straight line during the 24 hours. In putting on or shutting down, we have found that the new work is much more simple and easier to manipulate. As each retort is charged or burnt off, the valve is opened or shut; and in the latter case, the lever of the lid is slacked as well.

During the week prior to Christmas, we produced, by increasing the weight of coal per charge to 3¾ cwt., more than 170,000 cubic feet of gas per bed per 24 hours, 10,800 cubic feet per mouthpiece, and 11,100 cubic feet per ton; maintaining the usual illuminating power with a small percentage of second-class cannel. In consequence of time not permitting us to complete more than five beds, we have had to make these produce all the gas required. Previously 154 mouthpieces did the work, as against only 80 this year, notwithstanding an increase over the last year in the consumption.

Time has not allowed me to prepare very much information; but I am able to give you a few statistics of the work done in the retort-house. It has taken 182,000 hard common bricks, 220,000 fire-bricks, 60 tons of lias lime, 12 tons of Portland cement, 260 tons of special furnace-blocks and retort-pieces, 112 tons of fire-clay, and 9 tons of fire cement, as well as 170 tons of iron-work. The total cost, excluding the sale of any of the old material, will be about £43 per mouthpiece.

I have made a few experiments to ascertain the temperatures at various points, the amount of primary and secondary air passing to each furnace, and the draught at the base of the chimney and on the damper of the furnace, which I thought would interest you. During these tests, we were using 10¾ lbs. of coke for every 100 lbs. of coal carbonized actually weighed; and the average temperature of the retorts was 1820° Fahr., with five-hour charges of 3½ cwt. per mouthpiece. The coal used was all screened; and the coke came out well burnt off.

Temperature in combustion chamber . .	2400° Fahr.
,, ,, middle retort over ditto. .	1900° ,,
,, at exit from setting	1400° ,,
,, ,, main flue	770° ,,

These temperatures were taken by metals and the "alloys of metals," as no pyrometer could be obtained which would give anything like reliable information; and I shall be happy to show at the works the results produced on these metals in the combustion chamber.

Amount of primary air . . .	12,000 cubic feet per hour.
,, secondary air . . .	28,000 ,, ,,
Draught at base of chimney . .	2-10ths of an inch.
,, damper of furnaces .	1-10th ,,

In making these few remarks respecting the results I am obtaining, it is with the view of stimulating others to go and do likewise; for I do not claim any credit for perfecting or even improving the system I have adopted.

There are a few current topics upon which I ought to make some mention. The enrichment of gas by oil, in lieu of cannel coal, is now seriously engrossing the attention of most of us. I should much like some member who has been using this method for raising or maintaining the illuminating power, to be good enough to prepare a paper during my term of office, and give the Association the benefit of his experience; and more particularly to tell us whether during the past severe cold weather the results have been satisfactory. Water gas is still struggling along; but it does not meet with the support the

shareholders have anxiously looked for. Many fresh patents have been taken out during the past year; but still it does not make much progress. There is, however, ample field for a supply of fuel gas of low illuminating power; but until the difficulty of expense in duplicating mains can be overcome, I fear it will be impossible for gas-works to undertake the supply. The electric light has made considerable progress of late; but I think we need have little fear of it yet affecting our business, as invariably where it has been largely used the gas consumption seems to have proportionately increased. The sale of gas to small consumers by the prepayment system continues to grow in favour in some towns; but until landlords see the importance of assisting us by fitting up their houses, and so improving their property and the comfort of their tenants, many will not undertake the responsibility of supplying this class of customer.

Much praise and credit is due to those engineers who, by careful study and hard work, have enabled us now to construct our gasholders and guide-framing on more scientific principles. Still, I think the tendency to storing up the gas in stupendous holders is somewhat a mistake, as accidents are liable to occur when least expected; and the inconvenience and loss through one of these holders getting out of order is a serious matter.

Time will not allow me to detain you any longer, but I would wish to say how much we must all regret the sad accidents which have occurred in connection with tar-well explosions; * and it certainly behoves all of us to use extra care to provide against such mishaps, by examining during next summer all tar-pits, syphons, and overflows, so as to ensure ample and sufficient seal, and to guard against any accumulation of gas in the wells. Ventilation may, in a measure, carry off any gas; but it will not prevent an explosive mixture. Do not allow hot coke to be tipped near any well; and do not make a coke heap on it.

In conclusion, I have to thank you, one and all, for the great honour you have conferred upon me by placing me in the presidential chair; and I sincerely trust that, with your kind co-operation during my term of office, the prestige of the Association will be in no way impaired.

Mr. LITTLEWOOD proposed a hearty vote of thanks to Mr. Smith for his address.

Mr. C. HUNT (Birmingham) seconded the proposition; and it was carried.

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* Accounts of the accidents here referred to will be found in the *Journal of Gas Lighting*, Vol. LX., pp. 946, 1001, 1046, 1088, and Vol. LXI., p. 105.

PRESENTATION TO MR. SIMPSON.

The PRESIDENT said he had now the pleasure of calling upon Mr. Hunt to complete the presentation to Mr. Simpson.

Mr. HUNT remarked that the members would recollect that, at the last meeting, it was mentioned that an illuminated address was to have been included in the presentation to Mr. Simpson; and he had now pleasure in asking Mr. Simpson to accept it. The address was as follows:—

To PETER SIMPSON, *Esq.*

DEAR SIR,—We, the undersigned members of the Midland Association of Gas Managers, desire your acceptance of the accompanying silver salver and antique cup (dated 1757), in token of our high esteem and regard, and as a slight recognition of your valuable services to the Association, as one of its oldest members, a Past-President, and its Treasurer for eleven years.

In your retirement from active work, we are glad to know that you will still remain a member of the Association; and our fervent wish is that you may be long spared to enjoy in happy usefulness your well-earned leisure.

(The address was signed by 47 members, subscribers to the testimonial.)

In asking you, Mr. Simpson (continued the speaker), to accept this address, I am sure I am but expressing the desire of every member, as well as my own, that the good wishes expressed therein will be more than fulfilled. The silver pencil-case which I have also the pleasure of handing you, represents the balance of the fund.

Mr. SIMPSON: I am exceedingly obliged to you, and thank you most sincerely for your good wishes, as expressed in this very handsome address.

The business then closed.

VISITS TO TANGYES LIMITED AND THE SMETHWICK GAS-WORKS.

The members then partook of luncheon, after which they were conveyed in saloon carriages from Snow Hill Station to Handsworth; arrangements having been made for the party to visit the extensive works of Tangyes Limited. At the Cornwall Works the party were received by Mr. H. Lincoln Tangye, Mr. Treglown, and Mr. C. Pinkney, and escorted over the larger portion of the works; being all much interested, particularly in the gas-engine department. After the inspection, they assembled in one of the rooms at the offices, in order to express their obligations to Messrs. Tangye for their kindness. The President asked the members to accord to Messrs. Tangye a hearty vote of thanks for the exceedingly courteous manner in

which they had received them, and the splendid view they had given them of the improvements they had effected, not only as regarded steam-engines, but also the gas-engine. They were particularly interested in the latter, as it more deeply concerned the welfare of their profession. He felt sure that those who had seen what Messrs. Tangye had done in reference to the gas-engine would go away without any fear as to the future of this motive power. Mr. Hack (Saltley) seconded the motion; remarking that the inspection of the works had been most interesting to them as gas engineers. With respect to gas-engines, he observed that Messrs. Tangye had greatly improved on the original idea. He was pleased to hear that their engines were capable of doing as good work as the "Otto," and that they were introducing them for electric lighting. Mr. Lincoln Tangye, in acknowledging the resolution, said the firm were making excellent progress in the sale of gas-engines, which were, after all, most important from the visitors' point of view.

The members subsequently paid a visit to the gas-works of the Smethwick Local Board, over which they were conducted by the President; and this brought the day's proceedings to a close.

MANCHESTER INSTITUTION.

ANNUAL MEETING, MARCH 4.

This Meeting was held at the Palatine Hotel, Manchester. Mr. CHARLES ARMITAGE, F.C.S., the retiring President, occupied the chair at the opening of the proceedings.

MINUTES OF LAST MEETING.

The HON. SECRETARY (Mr. S. S. Mellor, of Northwich) read the minutes of the previous meeting; and they were confirmed.

NEW MEMBERS.

Mr. Alfred West (Rastrick) and Mr. James H. Whitell (Haworth) were unanimously elected members of the Institution.

REPORT OF THE COMMITTEE.

The HON. SECRETARY read the annual report of the Committee, as follows:—

The Committee, on presenting their report, are pleased to be able to congratulate the members on the continued usefulness and prosperity of the Institution.

There have been ten new members elected during the past year; three members have resigned; three cease membership under Rule I.; and one member (Mr. P. Hancock) has died during the year. This leaves ninety members on the roll of the Institution.

The annual meeting was held at the Grand Hotel, Manchester, on Saturday, Feb. 27, and was well attended. Owing to the unavoidable absence of Mr. T. O. Paterson, through an accident, Mr. W. W. Hutchinson, the immediate Past-President, was voted to the chair. After the usual routine business, Mr. C. Armitage was installed in the presidential chair, when he gave a very instructive and valuable address. The Secretary then read a very interesting paper, on "Management," which had been prepared by Mr. T. Newbigging, who was unable to be present.

The May meeting was held at Skipton, and was exceptionally well attended. A visit was paid to Bolton Abbey and Woods. The day being very fine, the visit was thoroughly enjoyed by all present.

The 91st quarterly meeting was held at Rochdale, on Saturday, Aug. 27. There was a good attendance of members. Amongst the visitors were Dr. Thorne, of London, Mr. S. Stormonth, of Coleraine, President of the North of Ireland Association of Gas Managers, and Mr. Thos. Stenhouse, F.I.C., F.C.S., Borough Analyst of Rochdale. Mr T Banbury Ball, on his own behalf and in the name of the Chairman of the Gas Committee, gave the members a very hearty welcome to Rochdale. Mr. Stenhouse then

contributed a valuable paper entitled "The Behaviour of Oxygen when Air is Used in the Purification of Coal Gas;" and at the close he gave a number of interesting experiments, after which a good discussion ensued. Subsequently, a number of the members and visitors were conducted through the works, and inspected the Coze system of inclined retorts and Brin's oxygen plant. Unfortunately, the members were not favoured with fine weather. Consequently, only a few paid a visit to Blackstone Edge and the old Roman road, which proved to be very interesting to those brave enough to undertake the journey in such unpropitious weather.

The November meeting was held at the Grand Hotel, Manchester, on Saturday, Nov. 28, when there was a large attendance. Mr. W. R. Chester, of Nottingham, was unanimously elected President for the ensuing year. Mr. Harrison Veevers read an interesting paper on "The Use of Oxygen in the Purification of Coal Gas," which led to a very animated and highly interesting discussion. Mr. W. R. Chester contributed a useful paper entitled "An Account of a Recent Explosion in a Tar-Well." A number of the members afterwards took part in the discussion; and they little thought that the reading of the paper was to be so shortly followed by a similar explosion at the Bradford Corporation Gas-Works.

The Committee are particularly desirous of calling the attention of members to the papers submitted during the past year on the use of oxygen in the purification of coal gas, which have been so highly interesting, and caused such considerable discussion and correspondence in the gas journals. The Committee venture to say that these papers alone are sufficient evidence to prove the good work that is being done in disseminating valuable information; and they trust that the subject will not be allowed to be dropped, but continued during the coming year. They now invite members to contribute papers on this very interesting subject, which is so important to the gas industry.

The retiring members of the Committee are Messrs. Foster and Lord.

(Signed) CH. ARMITAGE, President.

March 4, 1893. SAML. S. MELLOR, Secretary.

The report was adopted.

ELECTION OF OFFICERS.

Mr. J. Braddock, of Radcliffe, was next elected Senior Vice-President, and Mr. G. Smedley, of Buxton, Junior Vice-President, for the ensuing year; Mr. T. Newbigging being again chosen as Treasurer, and Mr. Mellor being retained as Hon. Secretary. Messrs. J. Niven (Clayton) and Mr. T. L. Sheppard (Farnworth) were elected members of the Committee; and Messrs. W. Smith (Hyde) and J. Mackenzie (Wilmslow) re-appointed Auditors.

THE RETIRING PRESIDENT.

Mr. ARMITAGE then said: The time has now arrived when I should vacate this chair, and introduce to you Mr. Chester, of Nottingham, whom you have chosen to preside over your deliberations during the coming year. I can assure you that

it is to me a great pleasure to introduce to you the President-Elect; and I have every confidence that he will fill the position with credit to the Institution and to the profession. Before leaving the chair, however, I would just remark how pleased I have been to occupy the onerous position of President, and further to thank you heartily for the support you have given me during my year of office. The meetings during the past year have been well attended; the subjects brought before you (especially that of purification) have been very interesting, and more especially in consequence of the correspondence which followed on the elimination of sulphur compounds other than hydrogen sulphide. The point in dispute is whether the product of calcium hydrate and hydrogen sulphide is capable of combining with carbon disulphide without the material being exposed to the air. One correspondent is of opinion that it is necessary that the product should be exposed to the air, or a small percentage of air should be admitted to the purifying-box. This is the general opinion of other engineers. Another correspondent entertains quite a different opinion; and he quotes Mr. V. H. Veley, who contributed a paper on the subject to the Chemical Society in 1885 (Vol. XLVII., page 490), in which it is distinctly stated that dry calcium sulphide does not, but moist calcium sulphide does, absorb carbon disulphide, and that the conversion of calcium sulphide or calcium hydrosulphide into calcium-hydroxy-hydrosulphide precedes the absorption of any appreciable quantity of carbon disulphide. Also that calcium-hydroxy-hydrosulphide suspended in water absorbs carbon disulphide. Thus the last-named substance is the absorbent formed either from calcium sulphide or calcium hydrosulphide. These changes of the sulphides are shown to be effected by the addition of water only, in accordance with the following equations:—

(1) $CaS + OH_2 = Ca(SH)OH$

(2) $Ca(SH)_2 + OH_2 = Ca(SH)OH + SH_2$

(3) $3Ca(SH)OH + CS_2 + OH_2 = 2Ca(OH)_2 + CaCS_3 + 2SH_2$

In Mr. Veley's communication to the *Journal of Gas Lighting* (Jan. 3, 1893, p. 22), he states that calcium hydrosulphide is inert towards carbon disulphide; but if air or hydrogen with carbon disulphide (an artificial mixture made to resemble impure gas) be passed through a solution of calcium hydrosulphide, a considerable quantity of hydrogen sulphide is given off, and simultaneously with the separation of the calcium-hydroxy-hydrosulphide, the absorption of the carbon disulphide

commenced, and eventually red crystals familiar to gas engineers were formed. These contained not only the hydrate, but also the sulpho-carbonate. This, I submit, is another digression in which hydrogen is shown to be the active agent. Now, if hydrogen has the power of bringing about these changes, there should be no difficulty in absorbing sulphur compounds without the addition of oxygen, as coal gas contains about 40 per cent. by volume of free hydrogen. It would, however, be very interesting to know the chemical actions that absolutely do occur; and I hope the day is not far distant when we shall be in full possession of the information, in order that we may be enabled to offer to the public coal gas in which the most fastidious cannot find any cause whatever to complain. However, our thanks are due to those gentlemen who have probed the subject to its present position; and I trust that they may continue their researches.

THANKS TO THE EX-PRESIDENT.

The PRESIDENT-ELECT (Mr. W. R. Chester) said his first duty was to propose a vote of thanks to the retiring President. He did this regretfully, because he felt that they were parting with a gentleman who had done his work exceedingly well in the past year, and had gained the popularity and admiration of the members of the Institution. Mr. Armitage was a painstaking chemist and a good engineer; and he had certainly added lustre to the presidential chair of the Institution.

Mr. PARKINSON seconded the proposition; and it was adopted.

Mr. ARMITAGE having briefly replied,

The PRESIDENT read the following

INAUGURAL ADDRESS.

Gentlemen,—In taking the presidential chair of this important Institution, it is my pleasing duty to congratulate the members on the continued prosperity of the Association, and at the same time to chronicle our satisfaction at the increasing prosperity of the business in which we are all so profoundly interested. The Association which grew out of an informal meeting of gas engineers called together some twenty-three years ago, to bid God-speed to a respected colleague then departing for South America, now ranks in point of numbers, with one exception—that of the North British Association—as the most influential of all the District Associations. But if we take as a measure of importance the volume of business controlled by its members, then it stands second to none in the power and influence it wields. Its usefulness as an educational

medium has during its existence been demonstrated over and over again, by the excellent papers which have, from time to time, been brought under its notice, and by the no less excellent discussions which these papers have developed. Whether the author of, or the listener to, a paper is the larger recipient of benefit from its consideration, is a moot point; but whatever benefit is derived, from an intellectual point of view, by the members of the Institution, the fruits of the interchange of experiences is reaped by the undertakings under the control of its members.

New discoveries, improved methods, new ideas, better systems of working, more economical results, increased output, diminished leakage, decreased capital expenditure to accomplish results—all, in turn, receive consideration. The experience of the individual is placed at the disposal of the Institution in the most unreserved manner; thus effecting immense saving in time and money, and enabling the gas undertaking to appropriate and adopt an improvement as soon as it is discovered and demonstrated. Since the foundation of The Gas Institute and its numerous offsprings in all parts of the country, improvements in gas manufacture have made more rapid progress during the past twenty years than in all the preceding sixty years since its first introduction—these improvements all tending in the direction of economy, and being the means of placing within the reach of the gas-consuming public a larger volume of light, with increased purity, at a reduced cost. The good practical work done by these Institutions, and the immediate benefits derived from their conferences, entitle them to the warmest encouragement, sympathy, and support of Gas Committees and Directors of Gas Companies at large; and I should like to see their efforts recognized and appreciated in a larger degree than has been customary in the past.

That something is being done in this direction, I can point with pleasure to the ready response made by a number of influential Gas Companies and Local Authorities to the appeal for funds made by The Gas Institute last year, to help them to carry on the work of investigation and research. So intimately are the interests of the purveyors of gas, and, indeed, the public at large, bound up with the welfare and success of these Institutions, that the money voted in promoting their work will be found to be a most profitable investment. It lies with the individual member to justify the higher appreciation in which these Institutions are beginning to be held, and to take care

that the work done is made known in the proper quarter, and then leave it to find its due appreciation.

During the period which has elapsed since the Paris Exhibition of 1881—when the practicability of illuminating by electricity was demonstrated on a large scale, and the investing public were first dazzled by its display—every year has brought some new and startling discovery, by which gas as a domestic illuminant was to be "snuffed out." In the ten or eleven years which have elapsed, hundreds of electric lighting companies have been registered, with millions of capital. In Great Britain alone, electric lighting companies have been registered with a total nominal capital of £9,700,000, of which £3,820,000 have been called up; and this sum is exclusive of the amount expended by municipalities and local authorities, of which at present we have no return.

How far this capital has been wisely expended, may be judged by the limited number of companies able to show any commercial success. Where success has been attained, it will be found that the company is in the happy possession of some compact and rich district of supply, in which cost is only a secondary consideration to the resident. If we take the cost at which electricity can be profitably supplied at 6d. per Board of Trade unit of 1000 watts, and compare this figure with that of 18-candle gas at 2s. 6d. per 1000 cubic feet, we get a comparative cost, light for light, of rather more than two to one in favour of gas. So long as these proportions are maintained (and there does not appear to be much prospect of them bearing a different relationship to each other), it will be impossible to supersede gas, or diminish its popularity as a domestic illuminant.

While every new electrical invention has been heralded in by the press with a great flourish of trumpets, and new companies for its supply have sprung up with marvellous rapidity on every side, the consumption of gas has steadily increased, and the prosperity of the undertakings supplying it have been maintained. The total capital invested in authorized gas undertakings in 1882 was £50,261,118; and in 1892 it was £63,620,461—showing an increase of 26·6 per cent. in the ten years. The consumption of gas, which stood at 66,614 million cubic feet in 1882, increased to 99,870 millions in 1892; or a total increase of 50 per cent. for the same period. This steady rate of increase is the more satisfactory when it is borne in mind that it has been won in competition with both the electric light and that obtained from the cheap mineral oils placed on the markets in such abundant quantities during the past ten years.

In commencing this second decade of the electric lighting era, we have less cause for anxiety than existed ten years ago. We are now in a position to more correctly estimate its cost of production, to gauge its possibilities, and to pretty accurately determine its usefulness. The mind of the public, as well as the timid shareholder, has now become more settled; and it is generally recognized that the two systems have their respective spheres of usefulness, and can be run in "double harness" almost without competition, and with mutual benefit to themselves and the public at large. It may, I think, be safely anticipated that in the next decade the prosperity of gas undertakings will not be diminished; the stimulating influence of a friendly competition will more rapidly develop the latent resources of the gas manufacturer; production will be cheapened; and consumption will increase as a natural consequence. If we look back over the period of the last seventy years, commencing in 1824, we shall find an almost unbroken record of diminution in the selling price of gas. This represents not a corresponding decrease in the cost of the raw material; for, while the latter has diminished 56 per cent., the selling price of gas has gone down 85 per cent., and this decrease has been coincident with a rise of wages of between 70 and 80 per cent. In London the following are the figures:—

Year.	Selling Price of Gas per 1000 Cubic Feet.	Cost of Coal per Ton.	Daily Wages of Stokers
	s. d.	s. d.	s. d.
1824 . . .	16 0	29 3	—
1833 . . .	11 8	18 3	3 8½
1843 . . .	8 0	20 2	4 0
1853 . . .	4 8	21 2	4 0
1863 . . .	4 8	18 2	4 3½
1873 . . .	3 6	31 7	5 0
1883 . . .	2 10	12 10	5 5
1893 . . .	2 6	12 9	6 7

The effect of this is perhaps best shown in the accompanying diagram (p. 40), which is based, so far as the selling price of gas and coal is concerned up to 1877, on one prepared by Mr. W. J. Warner, and given by him in his presidential address to the British Association of Gas Managers [now The Gas Institute] in 1879. Since 1877 the figures are those of the South Metropolitan Gas Company. The cost of wages is taken from the evidence given by Mr. George Livesey before the Royal Commission on Labour in May of last year.

The steady decline in the selling price of gas during the past seventy years, which is one of the best indications of a

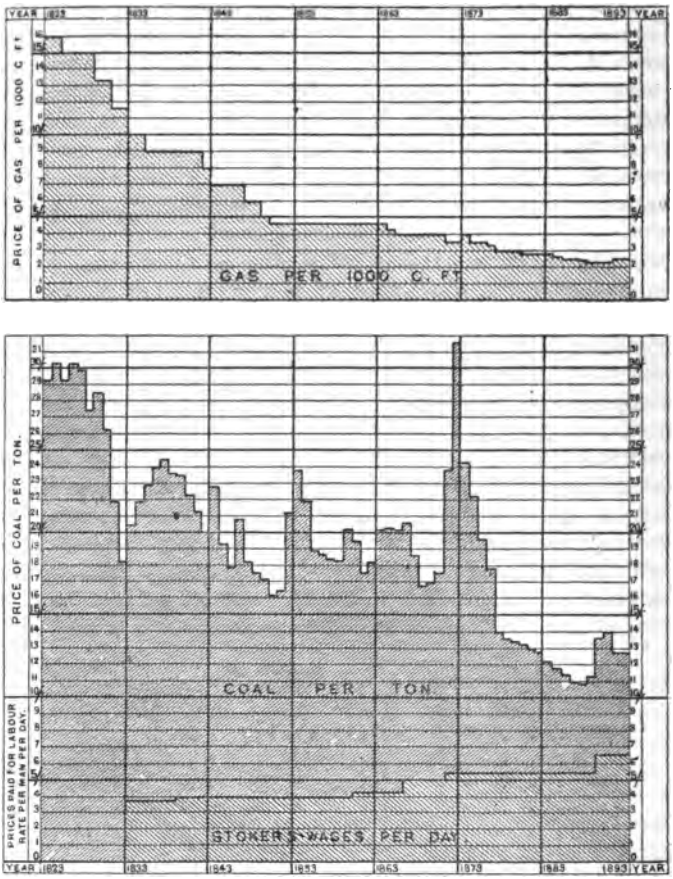

YEAR
PRICE OF GAS PER 1000 C FT
GAS PER 1000 C. FT
PRICE OF COAL PER TON.
COAL PER TON
PRICES PAID FOR LABOUR RATE PER MAN PER DAY.
STOKER'S WAGES PER DAY
YEAR

FIG. 1.—DIAGRAM SHOWING THE VARIATIONS IN PRICES OF GAS, COAL, AND LABOUR IN LONDON FOR THE SEVENTY YEARS ENDING 1893.

successful and prosperous business career, has in the main been brought about by the inventive resources of the engineer and the chemist, whose combined skill has succeeded in extracting the maximum efficiency from the coal, and at the same time reduced loss by leakage and waste to a minimum. By their efforts it has been possible to maintain the prosperity of the undertaking, to give substantial reductions in price to the consumer, and to improve the condition of the labourer, both financially and by giving him increased leisure. If it has

been possible to do so much in the past, is there still a margin for further advancement in the direction of cheap gas in the future? I think the signs are most hopeful; and it is not a difficult matter to indicate some at least of the influences contributing towards this result.

The most imminent is a probable reduction in the price of the raw material, which has apparently been carried beyond its legitimate market value, and which has already commenced to recede. I do not consider it desirable, in the interests of the gas maker or those of the general public, that the price of coal should decline to the low ebb of 1888, when in the majority of cases it could not be raised for the money. But between that and present prices there is so large a margin that a reduction may reasonably be expected when contracts are next made. A reduction or rise in the price of the raw material, however, is merely an incident of the market, and one for which no credit or blame can be taken or accepted by the engineer.

We may look to the introduction of the regenerator furnace, and its general adoption in gas-works, for a more satisfactory and permanent means of reducing the cost of production. The principle of gaseous firing has been under discussion for the last fifteen years; and though its theory is now well understood, and admittedly correct, yet its practical application has made but slow progress. The failures met with in its early application were largely due to want of knowledge of the fire-resisting capabilities of the material which it had been customary to use in the ordinary coke-fired setting, and also to an insufficient knowledge of the intensity of the heat which could be generated from the combustion of producer gases. The early retort-settings on the regenerator principle were constructed in the same manner, and with the same kind of material, as the old coke-fired setting, with the result that the interiors were soon gutted by the intensity of the heat, or the material was so softened that the retorts tumbled to pieces in the most startling manner. The material used was physically unfitted to withstand the intensity of the heat; but at first the requirements were so little understood, even by the most scientific of engineers, that in the light of our present knowledge the most foolish things were sometimes done.

I remember a system of regenerator settings being devised and erected under the supervision of the greatest authority in the country on gaseous firing of that time, where the lower portion of the regenerator flues were constructed of common

red building-bricks, on the expectation that the waste gases ere they reached this point would have lost so much of their heat to the secondary air, as to be quite harmless when brought in contact with the house-brick. The heats in the settings were splendid; but as they gradually descended to the main flue, and began to act on the common brickwork, we speedily had indications of the catastrophe which was about to ensue. The common bricks melted, and began to run off in lava-like streams; and the whole superstructure collapsed in slightly under three weeks from the time of lighting up.

The difficulty encountered in finding suitable fire-material to withstand the intense heats of the combustion chambers, has driven some engineers to "seek salvation" in a sort of half-way house, and others to fall back upon gaseous firing in its elementary form, lest greater evils befall them. In either case they sacrifice from one-half to one-third of the total advantages to be derived from a complete system of gaseous firing combined with regeneration.

The wastefulness of the direct coke-fired furnace is due principally to two causes—first, to the amount of unconsumed carbon which is lost in the frequent clinkering and disturbance of the fire; and, secondly, to the large volumes of cold air admitted during the process of clinkering and frequent feeding of the fire. In the gaseous-fired furnace, which requires feeding much less often, the deleterious effects of the cold air are reduced to a minimum, and almost every particle of combustible matter in the coke is utilized. In this way, an economy in fuel is effected to the extent of about 6 cwt. per setting per 24 hours, which represents roughly 8,000,000 units of heat. Now, if we stop at this "half-way house," we have accomplished a considerable economy in fuel and labour; but we have by no means carried the economy to its ultimate limit. The theoretical quantity of air required for the secondary combustion of the producer gases amounts to an enormous volume in the 24 hours —equivalent to about 270,000 cubic feet; and if we take this figure, and allow nothing for an excess of air which is a practical necessity, we shall require rather more than 8,000,000 units of heat to raise it to a temperature of 1800° Fahr., which is a little under the temperature at which the producer gases enter the combustion chamber. In other words, if we admit this volume of cold air to the combustion chamber, we must consume so much additional coke as will raise it to this temperature, in order to maintain the heat of the setting.

The temperature of the waste gases leaving the setting, after

having completed their work, is about 1900° Fahr.; and in the direct coke-fired furnace and the simple producer this heat passes to the chimney and is dissipated. But where the principle of regeneration is in operation, a large portion of this escaping heat is utilized in raising the temperature of the secondary air to that of the producer gases, and thus enables the temperature of the setting to be maintained with a diminished fuel consumption equivalent to 6 or 7 cwt. of coke per setting.

The advantages of the regenerator over the simple generator furnace are clearly demonstrated; and it only remains to select and adopt a suitable fire-brick to withstand the high temperature of the combustion chamber, to enable everyone to reap the full benefit of the regenerator principle. During a long experience, I have experimented with every kind of fire-brick known to me; and I am only aware of one which possesses in a high degree all the characteristics necessary in a brick which can be successfully used for this purpose. Providing this special fire-brick is used in and around the combustion chamber, the rest of the setting may be constructed of the ordinary Stourbridge or other material which it is customary to use; and the regenerator setting then becomes as durable as the most exacting person can wish.

If we compare the cost of a regenerator and an ordinary setting (apart from the first outlay in providing the producer and regenerator flues of the former), there is no material difference; and the cost of periodical renewals is about the same per mouthpiece for similar sized retorts. But as the ordinary setting requires two expensive repairs during a lifetime, and lasts only half as long as a well-constructed regenerator setting, the cost for wear and tear stands at about three to one in favour of the regenerator.

It may not be uninteresting to give here the results of a prolonged trial of the two systems working side by side, showing the wear and tear charges per ton of coal carbonized—

	Regenerator Setting.		Ordinary Setting.
	£ s. d.		£ s. d.
Original cost per mouthpiece . .	5 0 0	..	5 0 0
Repairs and re-furnacing . . .	nil	..	1 0 0
	5 0 0	..	6 0 0
Coal carbonized per mouthpiece during life	625 tons	..	231½ tons
Wear and tear charges per ton of coal carbonized	1·92d.	..	6·22d.

In addition to the reduction of the wear and tear charges of

4d. per ton, there is a further reduction in the cost for labour of 3d. per ton, and a saving in fuel equivalent to 1s. 5d. per ton, which together effect a combined reduction in the cost of production amounting to 2s. per ton of coal carbonized.

The efficiency of a retort must be measured by its first cost and the amount of work which can be got out of it in a lifetime. If we take the cost of a regenerator setting complete—with new walls, arches, main flue, furnace, regenerators, and settings, together with the new mouthpieces, ascension-pipes, hydraulic mains, relief mains, weir valves, excavation below the floor line, new floor, and everything fitted up in the best style—at £40 per mouthpiece, and the average work done by such a setting at 625 tons, the economy effected during the first life will recoup the whole cost, and leave a margin of more than 50 per cent. profit. After the first outlay has been incurred, the cost for renewals will not exceed £5 or £6 per mouthpiece; and the net profit on the second life of the retorts will be £50 to £55 per mouthpiece more than is possible with the old system of retort-firing.

Great as are the advantages of the new over the old system of heating retorts, the regenerator setting has not yet captured the whole of the larger gas-works, and has made but little progress in works of moderate size, only a few of the more enterprising of the smaller works having adopted the system. It may be confidently anticipated that the next ten years will see the system almost universally adopted, the effect of which will be a material reduction in the cost of producing coal gas.

The next most influential means of lowering the cost of production is the introduction of machinery for carbonizing. The field for this is not quite so extensive as that for the regenerator furnace, because, to employ a machine with the best results, the magnitude of the works must be such as to give it full employment. When it can be used with full advantage, the economy effected ranges from 1s. 6d. to 2s. per ton of coal carbonized. The inventive resources of engineers have for many years (almost from the commencement of gas making) been turned in the direction of providing a machine to minimize the laborious work of the stoker, and many systems have been tried; but, owing to the complicated nature of the work to be done, few have ever got beyond the works in which the invention was incubated and the machine was first applied. With one notable exception, machine after machine has had to be abandoned; and there is but one system in which the practical advantages have been such as to secure it a wide

adoption. There is still a large field of usefulness for the application of machinery, and the magnificent specimens which have lately been turned out by Messrs. West and Co., of this city (and which I had recently the privilege of seeing in operation at the South Metropolitan Gas-Works in London), will do much to encourage a more universal adoption of this means of still further lowering the cost of production.

The application of the inclined retort as a means of minimizing cost is receiving considerable attention; and, as it can be utilized in small installations, it offers many attractive features to moderate-sized works. Whether it possesses any advantages over the horizontal retort and stoking machinery, I am scarcely in a position to judge, as I have had no personal experience in working it. It appears, however, to possess one considerable drawback, in being dependent on the natural force of gravitation to effect an even distribution of material in the retort. Providing every class of coal used in a gas-works were uniform in size and physical condition, the inclination of the retort could be made to suit the force of gravitation, and an even distribution might thus be effected. But as this is a practical impossibility, there will always be a considerable degree of uncertainty in the satisfactory working of the system. The mechanical stoker, being entirely under control, does this with perfect certainty; and nothing is left to the uncertain and sometimes arbitrary action of a natural force.

Among the minor matters tending to economy in production which are likely to be effective in the present decade, are the application of machinery to the conveying of coal and coke to various parts of a gas-works. Several successful installations have already been applied—the most notable being the coal conveying and stacking machinery of the Oldham Corporation, and the coke-conveying scheme of the South Metropolitan Gas Company. Many other works are now contemplating advances in this direction; and we may expect to see the system much extended in the next ten years. In connection with this conveying system, considerable advantages are to be obtained from the erection of coke-hoppers for rapidly loading carts and railway trucks; and the erection of apparatus for breaking, sorting, and washing coke for smithing and domestic use. There is a large and profitable business to be done in broken coke; and I commend the cultivation of a trade in this direction to those members of the Institution who are accustomed to carbonize a high-class coke-producing coal.

Leaving now the directly productive portion of a gas-works

plant which may be expected within the next ten years to effect considerable economies, I will briefly refer to two of the indirectly productive portions, which are likely to exert an important influence in the same direction.

There is no department of a gas undertaking in which more important advances have been made than in gasholder construction. The colossal holder just completed by Mr. Livesey for the South Metropolitan Gas Company is in itself a triumph of engineering skill, reducing at once the capital charges per 1000 cubic feet of storeage capacity to one-half the sum formerly considered a minimum figure, and to one-sixth of that which was customarily expended for storeage plant but a few years ago. The inventions of Mr. Gadd, for abolishing the upper guide-framing of gasholders, and that of Mr. Pease, for guiding by wire rope, mark most important departures in gasholder construction, all tending to greater economy in the provision of storeage capacity, and consequent lowering of the price at which gas can be sold.

After having produced our gas cheaply, we may still further lessen the selling price by increasing the consumption; and the invention of the prepayment meter has placed within our reach an instrument which will greatly help in this direction. The average consumption of the prepayment meter will reach approximately 10,000 cubic feet per annum; and, therefore, the addition of each hundred meters will add to the consumption one million cubic feet per annum. Under the former system of supply, the cottage consumer was by no means a desirable customer. His account was small, and difficult to collect; and the bad debts were numerous. By the prepayment system of supply, bad debts are abolished; and the cottager becomes a desirable acquisition, and an eager consumer, likely to contribute in no small degree to increase the consumption of gas, and to give it a wider popularity as a domestic illuminant.

The fall in the prices of tar products has been the most conspicuous of the commercial aspects of gas undertakings for the past year. But depressed as the market is in these products, there is in my opinion no justification for the low current price at which tar in many instances is being sold to the distiller; and there is no wonder that the gas maker should have his attention turned towards the distillation of his own tar. In some instances, plant for this purpose is already being put down; and other gas-works are contemplating a step in the same direction. There is happily for the moment an improvement in the value of

sulphate of ammonia, which will do something towards equalizing the loss on tar, in the case of those undertakings who work up their own liquor.

In conclusion, I must thank you, gentlemen, for the honour you have done me in electing me your President for the ensuing year. The distinction with which this presidential chair has been filled in past years by my predecessors, will ever be an incentive to me to do my best, while occupying it, to uphold and promote the interests of the Institution.

A vote of thanks was accorded to the President for his address; and the proceedings then closed.

The members afterwards took tea together.

EASTERN COUNTIES ASSOCIATION

HALF-YEARLY MEETING, MARCH 13.

This Meeting was held in the Council Chamber, Cambridge. During the first portion of the proceedings, Mr. W. BARRATT, of Grantham, occupied the chair, in the absence of the retiring President (Mr. C. E. Jones, of Chesterfield).

AN OFFICIAL RECEPTION.

Mr. BARRATT, having taken the chair, introduced to the meeting the Town Clerk (Mr. J. E. L. Whitehead).

The TOWN CLERK said he had been instructed by their worthy Mayor (Mr. S. L. Young), whose health did not admit of his being present, to give the members of the Association a very hearty welcome to the town.

Mr. BARRETT said he hoped the Town Clerk would convey to the Mayor the sympathy of the meeting, and their regret that he was compelled to be absent.

The HON. SECRETARY (Mr. H. Wimhurst, of Sleaford) then read a letter from the Chairman of the Cambridge Gas Company (Mr. Dennis Adams), in which he expressed his regret and disappointment at being debarred by illness from the pleasure of being present at the meeting; and according to the Association, in conjunction with his brother Directors, a warm welcome to Cambridge, and an assurance of the high appreciation they felt for the great utility of such a combination as the Association provided for conference in advancement of interests connected with gas companies.

A vote of thanks was passed to Mr. Adams for his kind welcome and of his appreciation of the work of the Association.

MINUTES OF LAST MEETING.

The minutes of the meeting held at Lowestoft in September, 1892, were confirmed.

NEW MEMBER.

On the proposition of the SECRETARY, seconded by Mr. A. J. YORSTON (Ely), Mr. John Dixon, of North Walsham, was elected a member.

Annual Report.

The following report, with the statement of accounts, was then adopted :—

Your Committee have pleasure in presenting their fourth annual report to the members of the Association, and express satisfaction at the progress made during the year. Two half-yearly general meetings have been held—the spring meeting at Sleaford, and the autumn meeting at Lowestoft.

The number of members on the 1st of January, 1892, was 54. Ten new members were elected during the year, and two members have severed their connection with the Association under Rule 17—leaving the number of 62 as members on the 1st of January, 1893, which number the Committee hope will be added to during the current year.

The accounts show that the year began with £7 10s. in hand; and subscriptions amounting to £30 9s. have been received—making a total of £37 19s. The expenditure has been £24 0s. 4d.—leaving a balance in hand at the end of the year of £13 18s. 8d.; and five subscriptions outstanding.

At the spring meeting, the President (Mr. C. E. Jones) delivered his Inaugural Address, which was of very great interest to the profession; and Mr. J. H. Troughton read a paper on "Consumers' Fittings," which gave rise to an interesting discussion. The members and friends dined together at the Bristol Arms Hotel, Sleaford, at the termination of the business.

The autumn meeting of the Association was held in the Young Men's Christian Association Rooms, at Lowestoft, under the presidency of Mr. C. E. Jones, when Mr. W. J. Carpenter read a very valuable paper upon "Carbonizing Methods, Past and Present," which elicited a good discussion.

Prior to the meeting, the members and friends met at the Suffolk Hotel, Lowestoft, and were most hospitably entertained to luncheon by the Water and Gas Company of Lowestoft; the Chairman (Frederick Morse, Esq.) presiding, supported by the Mayor of Lowestoft (B. M. Bradbeer, Esq.), J. Ayris, Esq. (the Engineer), and other gentlemen. After the meeting, the whole number were conveyed in coaches to visit the Company's water-works at Lound, at the invitation of the Directors, much to the enjoyment of all present.

The members and friends dined together in the evening at the Suffolk Hotel, under the presidency of Mr. C. E. Jones, supported by the Mayor, F. Morse, Esq., Colonel Seppings, H. Leman, Esq., J. Ayris, Esq., and other gentlemen—the usual loyal and other toasts being honoured.

The officers for the year 1893 were elected at this meeting, as follows: President, Mr. W. Duesbury; Vice-President, Mr. W. J. Carpenter; Hon. Secretary and Treasurer, Mr. H. Wimhurst; Auditors, Messrs. F. Weller and A. J. Yorston; Committee, Messrs. T. H. Martin, A. Drage, and W. J. Wells.

The thanks of the Committee are due to those members who have contributed papers during the year; and the Committee express their desire that each member will undertake a similar task in future, and that each will use his influence on behalf of the Association by inducing gentlemen to join in the work of the Association by becoming members.

The New President.

Mr. Barratt said his next duty was to introduce to the members the President for the ensuing year, Mr. Duesbury.

The President, on taking the chair, said he would first propose a vote of thanks to the retiring President.

Mr. J. G. Hawkins (Spalding) seconded the motion, which was unanimously agreed to.

The President, before reading the following address, remarked that since their last meeting, two of the gentlemen who welcomed them when they visited Cambridge in 1891—the then Mayor (Mr. F. C. Wace, M.A.) and the Chairman of the Gas Company (Mr. Alderman C. Balls, J.P.)—had gone over to the majority.

INAUGURAL ADDRESS.

Gentlemen,—In addressing you to-day, I shall not attempt to deal with the higher and scientific branches of our profession; but ask you to excuse my shortcomings while I attempt to bring before you a few subjects of general importance and, I hope, of interest. During last year, we, as members of the gas industry, have had conditions to contend with that have had a prejudicial effect upon our finances. These are chiefly the low price of residuals; my Company alone having received in the past half year £800 less for tar and ammoniacal liquor than they did in the corresponding half of 1891. I am pleased, however, to say that these residuals are now realizing a higher price than last half year. The price of coal has shown a somewhat downward tendency, although the new railway rates, if persisted in, will bring the price up again. But this at present appears doubtful, as the public are strongly demanding a return to the former rates. We, as an Association, have great cause for congratulation on our continued prosperity; and I think we shall all agree that this is chiefly in consequence of the exertions of our capable and energetic Hon. Secretary and Treasurer (Mr. Wimhurst), to whom our united thanks are due.

I have now been connected with the gas industry over fifty years; and it will perhaps be of interest to draw a few comparisons between the mode of manufacture then and at the present time. Small iron retorts, with a make of about 2000 cubic feet

per mouthpiece, and 7000 cubic feet per ton, have been superseded by the modern large clay retorts, making 7000 or 8000 cubic feet per mouthpiece, and over 10,000 cubic feet per ton. Dips of 4 inches and upwards are supplanted by the present small dip or anti-dip arrangement. Exhausters were very rare; and there was then no efficient scrubbing plant. The purifiers were generally charged with lime in a liquid state, which, when fouled, formed a most disagreeable refuse known as "Blue Billy," a very different state of things to the purifying at the present day. The station meters have also undergone considerable improvement; but perhaps in no department is the difference more marked than in gasholder construction, as witness the very small counterbalanced holders at that time in use and the large gasholders of the present day—all types of the progress of engineering skill, particularly so the colossal structure just completed at East Greenwich to the designs and under the direction of Mr. Frank Livesey. Indeed, it may be said that gasholder construction has undergone a complete reformation at the hands of engineers, as, besides the many splendid types of external guide-framing, we have the holders constructed on Mr. Gadd's system of internal spiral guides and Mr. Pease's wire-rope system, both of which dispense with, and save the cost of the usual guide-framing. Many consumers were then supplied with gas without a meter (there being a prejudice against them); the charges being based on the number and size of burners, and the number of hours in use, according to agreement. The price of gas at that time was about 10s. per 1000 cubic feet (subject to a small discount for prompt payment), and with an illuminating power of 10 to 12 candles. Burners have also been very considerably improved, as compare the old single jet or rat-tail and iron slits with the many splendid patterns now in use. Many of the streets in the large towns derived their light from oil-lamps, and what few gas-lamps were used were small, inefficient, and very far apart, giving light to only a very small portion of the area requiring light—a great contrast to the best systems of lighting at the present time, as carried out by the aid of the lamps of Messrs. Sugg, Bray, and other manufacturers. All this goes to prove the great strides that have been made in all branches of our industry; and this progress is still going on.

The buying and storing of coal is one of the first and most important items we have to deal with. I think it is advisable to buy coal of the best quality (at a fair price), especially where gas of a high illuminating power has to be supplied, as, except

the value of the coal in the pit unworked, all charges for labour, plant, and carriage are the same per ton for inferior as for better coal. The last item—the carriage—forms a very considerable part of the total cost of the coal used in this district; it being at Cambridge 42 per cent., and, if cheaper coal was used, it would, of course, be more. This argument also holds good in regard to the expenses of storing and carbonizing. Better coke is also made from the better coals, the good quality of which, I find, greatly increases the local sale. The cost per 1000 cubic feet of gas made from the best class of coal will work out very favourably with that obtained from coal of an inferior quality. Buy, as far as possible, coal with which you are well acquainted, or have strongly recommended to you, and let your specification be fair, but very firm. It is also advisable to buy from different coal-fields if possible, so as not to have your supply altogether cut off in the event of district strikes.

I think it would also be to our advantage if gas managers generally would buy and receive coal in more regular consignments. In storing, the better coal, again, has an advantage; as, being free, or nearly so, from pyrites, there is really very little risk of firing. In proof of this, notwithstanding that we keep very large stocks of coal, I have never seen or heard of any signs of heating whatever, and this where no means of ventilation are taken. Of course, in most cases the small depth of the coal would prevent firing. As the labour in the coal-fields is still in a very unsettled condition, and likely to be so, consequent on the demands of masters and men, it has become a necessity to lay in large stocks, so as to have on the works (in case the supply is entirely stopped) sufficient coal to carry us over the next six or seven weeks. This large stock is also, in my humble opinion, much better under cover, and will well repay the outlay of capital on the necessary sheds for this purpose. The coal-sheds should be in close proximity to the retort-houses, and should be well built, lofty, the floors solid and dry, and slightly higher than the surrounding ground. By having our coal under cover, we are thus enabled to carbonize dry coal at any time when necessary through low heats, which have been produced by using fresh wet coal. A large percentage of the sulphur compounds is left in the coke when dry coal is carbonized, which, if the coal was wet, would be carried to the purifying plant. The deterioration of coal, consequent on exposure, is also considerably reduced. Now that such large stocks of coal are necessary and general, it entails a large amount of labour in storing and removing the same, so that

conveyors or aërial ropeways will doubtless come largely into use, except in very small works, as they will tend to decrease the cost of manufacture—in fact, mechanical appliances are coming into general use throughout the whole of the works, with very beneficial results, particularly in the retort-house.

As to fire-clay goods, I certainly think that the best quality should be used, as the same arguments hold good here as with coal; very often good labour being almost thrown away on bad material. I also recommend, where possible, that a good stock should be on hand, the same to be under cover.

I should be pleased to see a Committee formed for the purpose of fully considering the sizes and patterns of retorts, with a view to making standard sizes and patterns, and so reduce the hundreds now in use. This step is certainly necessary; and, if a proper and workable basis could be decided upon, I feel assured that it would be of great benefit to the gas industry at large. This would, of course, apply chiefly to clay retorts, and partly to brick retorts; the latter being preferred by some engineers.

There are very many good systems of retort-settings; but without doubt the recuperative system is by far the best, both for economy of fuel and results of carbonization. Either the recuperative system proper, or a modification of the same, may be used with great advantage on even the smallest works. I do not know of a single failure where this system has been tried, provided that the settings have been built with care, and on a good plan, and that materials of the requisite good quality have been used. The first outlay entailed by a recuperative setting is certainly heavier. But the expenditure for repairs is very much less than for an ordinary setting; and the coal carbonized per mouthpiece for the total time in use is more than doubled, notwithstanding that only the same amount of coke for fuel would be required in each case. Both the make per ton and the illuminating power are also increased by the regular heat that is obtained. The ascension-pipes should be of large size, and a good distance from the face of the setting, which, I think, is a great preventative of stopped pipes. The hydraulic main should have a shallow liquor but large gas space, and carried independently of the stack; also fitted with apparatus for the immediate removal of the tar and regulation of the seal, which should be small, so that the exhausters can be worked at level gauge or very little suction. The main should be provided with screens lying on the top of the liquor, to keep the same from oscillating,

and consequently the dip normal. The foul main should be of large size, both in diameter and length; so that the gas may be gradually cooled before coming to the condensers. Sudden fall in temperature causes great deposition of valuable hydrocarbons, and consequent deterioration in illuminating power.

At my works the gas passes through the exhausters before coming to the condensers—an arrangement that seems to answer remarkably well; the tar acting as a lubricant. The condensers should be capable of being regulated, so as to keep the gas at a normal temperature under varying conditions of the gas and atmosphere. Condensers of the annular type, or one of the several patterns of water condensers, are best adapted for this purpose. I give my preference to the latter, both on account of space and efficiency. The warm gas, on entering an annular condenser, is subject to the action of a cooling agent of the same low temperature as exercises its influence on the cooled gas as it leaves the apparatus; while in a water condenser the temperature of the cooling agent is lowest where the gas is in a cooled condition—*i.e.*, at the gas-outlet, and highest at the gas-inlet. The gas and the water pass through the condenser, entirely independently of each other, and in opposite directions; the water absorbing the heat of the gas, its temperature being raised, while the temperature of the gas is, of course, reduced. But the chief point is that we have the gas cooled by an agent with a lower temperature, the degree of which varies in direct proportion with the temperature of the gas; the water as it leaves the condenser near the gas-inlet having a temperature approaching that of the gas itself. Thus we have very gradual and almost perfect condensation.

Any of the best types of washers are efficient—being capable of removing the whole of the tar from the foul gas, also other impurities; but some have the disadvantage of causing much back pressure. Of the various types of scrubbers, I think the tower scrubbers, filled with boards on edge, are the most efficient, especially if worked in pairs; liquor being used in the first and clean water in the second. The weak liquor, on leaving the second (having removed the last traces of ammonia and a little carbonic acid and sulphuretted hydrogen), can, with advantage, be run into a cistern, which also receives the liquor from the hydraulic main and the condensers. This liquor can then be pumped to the top of the first scrubber; and, as it contains a large percentage of free and combined ammonia, it will remove a large quantity of the sulphur compounds and carbonic acid.

The purifiers should be of large area—say, one superficial

yard of grids to every 1000 cubic feet of gas produced per 24 hours with the maximum make; with an adequate space for the gas between each layer. A set of six purifiers, I think, is best, so as to have working at one time (except when emptying) four lime boxes (the first two for the elimination of carbonic acid, and the second two for the sulphide of carbon) and two oxide boxes for sulphuretted hydrogen. Much material, labour, and nuisance are saved by the admission into the gas, before purification, of a small percentage of oxygen, either pure or diluted, as in atmospheric air. Either can be employed with great advantage; but the air has to be used with care, as, if a too large percentage is admitted into the gas, it results in a serious reduction in the illuminating power. Oxygen is no doubt the best; and I note that our friend Mr. Barton has drawn in oxygen, so as to keep up constant revivification, and that he has known instances where the purifiers have been charged with fresh oxide and not discharged until the material contained nearly 60 per cent. of sulphur. This is, no doubt, an exceptional case; but it shows what can be done under favourable conditions. Not only is there a saving of material and labour by the use of oxygen, but it is also stated by some engineers to improve the illuminating power to such an extent as to obviate the use of cannel. Spent lime in some districts realizes a good price; but at some works it cannot be even given away. We at Cambridge are unfortunately to be numbered amongst the last-named; and I shall be pleased if one of our members, at some future time, will give us a paper on the "Recovery or Disposal of Spent Lime."

A station meter is essential on even the smallest works, both to ascertain the quantity of gas made, and also from that datum to find out the quantity of gas unaccounted for or lost by leakage. Holders should have a capacity at least equal to the maximum consumption for 24 hours; and a reasonable outlay of capital on the holders to obtain this, is amply repaid by the wear and tear saved on the carbonizing plant.

Distribution is a very important part of every gas undertaking; and upon the manner this work is executed depends, to a great extent, the percentage of gas that is (as we term it) unaccounted for. Hence the importance that this work should be carried out in the best manner possible, both as to materials and labour. The trunk mains should be of sufficiently large diameter; and I believe it would be better if the branch mains were not reduced in size to so great an extent as they now generally are. I never lay any mains of less than 3 inches in

diameter. The extra cost of the increased size of the mains is only a small proportion of the total cost; whereas the reduction in the leakage account, through less pressure being required, is considerable. I may here state that our unaccounted-for gas last year was reduced to a little over 3 per cent. of the total make. The mains should be laid at a depth of not less than 2 feet, so as to avoid breakage; and the gas is thus less liable to the action of frost. This also enables us to lay the services deeper, and with a good fall to the mains.

I find it much the best not to lay less than ¾-inch services up to the meters, which may be either wet or dry—some gas managers preferring one kind and some the other. Dry meters are certainly less trouble and expense, and are not liable to stoppage on account of frost. Laying service-pipes in V-shaped channels, and covered with hot pitch, greatly prolongs their durability, and will repay the extra trouble and cost. I know some managers who lay galvanized wrought-iron pipes, and others wrought-iron pipes for steam; and they state that in the end they are cheaper than ordinary gas-tubing. In some districts lead pipes are found to be the best and cheapest for services.

The subject of internal fittings was efficiently dealt with in a paper read at the last annual meeting by our friend, Mr. Troughton,* in which he gave the sizes and lengths of pipes to be used for the number of burners required. This subject deserves great attention, as gas companies frequently get blamed for a deficient and poor supply of gas, or unsteady lights, when they are really giving a good supply of gas of a high illuminating power; the fault being really due to imperfect fittings or to burners of a very wasteful, inferior kind, or to burners of a good class that have become worn out. There is very little doubt that, if governor burners were more generally used, we should have very many less complaints. Some engineers, notably our friend Mr. Valon, strongly recommend that houses be fitted up by the owners of gas-works (whether companies or corporations), and the cost incurred be recovered by charging in these cases an extra price for the gas consumed. I have given this subject great consideration; but at present I cannot see my way to recommend such a course to my Directors for their adoption. I am, however, certainly of opinion that gas-fitting of all descriptions should be carried out with as little expense as possible to the consumer, particularly so in the case of stoves and fires, so as to encourage the use of gas in every

* See "Reports of Gas Associations" for 1892, p. 53.

way. As a further inducement, my Company are at present allowing a discount on stoves and fires of 25 per cent. for cash. They also encourage consumers to buy rather than hire.

The next question that I wish to bring to your notice is that of public lighting. In some towns the corporation have the sole control of, and supply to, the lamps. In others they have the control, supply, and maintenance of the lamps and fittings, the companies merely supplying the gas; or, as is the case at Cambridge, the Corporation decide upon the position of the lamps and the quantity of gas to be used, the Company providing the gas, columns or brackets, lamps, and fittings complete; also the lighting, extinguishing, cleaning, and the general maintenance, charging a fixed sum per lamp per annum. But I certainly am of opinion it is much better for the gas company to supply gas only—the corporations finding all fixtures and the lighting, &c., of the lamps. I think that it is also better to charge on the average-meter system, having governors fixed to all lamps and a meter (say) to every sixth lamp, as a fairly correct result is thus obtained. In large and busy thoroughfares, the high-power lamps as supplied by Messrs. Sugg, Bray, and others may be used with advantage to all.

Since our last meeting at Cambridge an Electric Supply Company has built works, laid down plant, and commenced supply. I am, however, pleased to say that a good feeling exists between us. The great cost of the production of electric light will, however, at present prevent it coming into general use. No doubt, one reason for its popularity is its novelty; and it still must be regarded as a luxury. There is, however, ample room for both gas and electricity; and notwithstanding a decreased consumption during the hours that shops are lit up, we hope, by further increasing the use of gas for domestic purposes and power, to maintain our usual increase. I may here state that the Gas Company sold over £10,000 worth of shares last month; and they realized a higher price than they did in 1890—thus positively showing, I think, that the public are still believers in the use of gas, and in the continued prosperity of gas companies. Oil is also a great competitor, on account of its cheapness, and the small outlay required for lamps; but it has many disadvantages—notably its danger and trouble.

I am pleased to congratulate you on the present settled state of our workmen. This, I think, is chiefly due to the firm yet fair manner in which their demands have in most cases been met. I think it behoves us all, as managers, to treat the men who are under us in a fair and considerate manner, and to

endeavour, as far as possible, to elevate their moral tone, as, by so doing, we shall not only benefit the men, but also our employers. I think it advisable that the proprietors of gas-works, whether companies or corporations, should create a general provident fund, and assist their employees to maintain the same; so that it can be used or called upon in case of sickness, old age, or death. The step thus taken should make the workmen take more interest in their work, because of the provision made for them. It would also have a tendency to elevate their character, and make them thinking men, and not mere machines, as too many now unfortunately are; and I feel sure that, in a little time, there would be less cause to complain of the great prevalence of excessive drinking among our stokers and other men.

There is one more subject that I wish to touch upon, and that is, that I believe in the near future it will be advantageous to reduce the illuminating power of gas, and, consequently, to a large proportion, the cost of production, so as to be able to supply it at a lower price, and also prevent the great waste that is now taking place by using gas of high illuminating power (in my case, 18 candles) for heating, cooking, and motive power. The same amount of light as now could be generated by using more, larger, or better burners—among the latter being the incandescent Welsbach.

It now only remains for me to sincerely thank you for the honour you have done me in electing me your President for the ensuing year. I feel the responsibility to be very great, and only accepted the position after much hesitation. However, I trust that I may successfully discharge the duties in connection with the office; and it shall certainly be my endeavour, whenever possible, to further the interests of this Association in particular, and of the gas industry in general.

A vote of thanks was accorded to the President for his address.

A resolution was passed requesting the Committee to take into consideration a suggestion for altering the date of the spring meeting; and it was decided to hold the next meeting at Melton Mowbray.

Votes of thanks to the President for his conduct in the chair, and to the Hon. Secretary for his services during the half year, were passed; and the members, with a number of friends, dined together in the evening at Ye Olde Castel Hotel.

SOUTH-WEST OF ENGLAND ASSOCIATION.

HALF-YEARLY MEETING, APRIL 11.

This Meeting was held at the Great Western Railway Gas-Works, Wormwood Scrubbs—Mr. E. C. RILEY, of Swindon, the Company's Gas Engineer, in the chair. At the previous two meetings of the Association, the members had before them the subject of the lighting of railway trains by oil gas; and they decided on the last occasion—Mr. Riley having been elected to the presidency—to hold the spring meeting in 1893 at Wormwood Scrubbs, in order that they might have the opportunity of examining the plant in operation there for producing and compressing oil gas.

On assembling shortly before noon, the visitors were conducted by the President round the works, some particulars concerning which will be found in his Inaugural Address; and they afterwards entered upon the business portion of the day's proceedings.

The HON. SECRETARY and TREASURER (Mr. N. H. Humphrys, of Salisbury) read the notice convening the meeting.

On the motion of the PRESIDENT, seconded by Mr. T. W. R. WHITE (Sherborne), the minutes of the previous meeting, held at Bournemouth in September last year, were taken as read.

NEW MEMBERS.

The PRESIDENT said the following applications for membership had been approved by the Committee; and he had much pleasure in moving their acceptance: Messrs. W. H. Green, G. M. Robins, and E. H. Stace, of Bournemouth, and G. W. Thomas, of Ringwood.

Mr. S. W. DURKIN (Southampton) seconded the motion, which was unanimously agreed to.

The PRESIDENT then read the following

INAUGURAL ADDRESS.

Gentlemen,—My first duty is to tender my sincere thanks for the honour you have done me in electing such a comparatively

young member of the Association to the important post of President. I should have preferred for some time longer to have occupied the position of a private member; but, since it has been your pleasure to confer upon me this mark of your confidence, I shall endeavour to do all I can to promote the objects for which I conceive the Association exists—viz., the consideration and discussion of both the principles and practice of the department of manufacture in which we are engaged.

Already this year, the Presidents of several District Associations have delivered inaugural addresses, which appear to have touched nearly every question of interest in modern gas manufacture; and it will be almost impossible to bring new features or fresh subjects before you to-day. I will not, however, assume that, like the ancient Athenians, you are ever thirsting to hear some new thing, but that what we really want is to consider the questions arising in the course of our own experience, and the advantages and disadvantages of methods, arrangements, and appliances in the light of our own practice, in order that our views may be enlarged, modified, or corrected by comparison with the experience of others. My own experience, as a Railway Gas Manager, lies in some respects in a different groove to most of those present, as the details of working both coal gas for general use, and oil gas for train lighting, particularly in distribution, are not in several respects the same as that of a company or local authority supplying the general public. Instead, therefore, of attempting a review of the gas industry generally during the past year, or an examination of the latest theories or departures in gas matters, I will content myself with looking at several features of our work as they have touched my own experience—a line so usefully taken up by Mr. Smith, of Smethwick, in his address to the Midland Association.*

In many cases, the cost of the coal, before it finds its way into the retort, is much greater than it should be, owing to the question not having been considered in all its bearings. The mistake has perhaps originated in the site of the works, through want of care in its position in relation to water or railway, or neglect in taking full advantage of difference of levels in saving labour, and in the location of coal-stores and stocks, so that the cost of second handling shall be reduced as much as possible. These site difficulties are, I think I ought to say, not always the fault of the engineer, as there are often many diverse influences and interests which affect this first and most important step. This question of saving labour in handling both coal and coke is,

* See *ante*, p. 20.

I notice, receiving much attention from the great companies and corporations of our largest towns and cities, who are spending large sums in the provision of high-level lines, conveyors, and elevators; but I would venture to submit that, subject to the proportional and proper limits of expenditure, smaller works might find advantage from careful attention to these questions. In the largest works belonging to this [the Great Western Railway] Company at Swindon, in connection with an extension of the retort-house made recently, inclined roads, carried on brick arches, have been laid up to the tops of the coal-stores; so that hopper-waggons may be used to drop the coal directly into its place without the intervention of the shovel. Also a deep dock or siding has been provided for loading the coke into the railway-trucks direct. This is in connection with an arrangement of trolleys for receiving and loading the coke. Light tram lines have been laid close to, and parallel with, the front of the retort-beds; the tops of the trolleys passing just under the middle row of mouthpieces—the bottoms being retained for supplying the furnaces. Two charges are drawn into each trolley each journey; and then they are pushed down to the end of the retort-house, and stopped over drainage pits with water-cranes above them. A valve, placed in a convenient position for the stoker's hand, enables the water to be turned on for a minute; and, when the coke is fully quenched, the trolley is pushed a few yards further to bring it exactly opposite the truck being filled, the scoop of the trolley is swung round, and the contents tipped into the railway-truck ready for despatch to any point desired. We found a little difficulty at first in getting the men into the new arrangement, as we had to start it during the heavy make in November. I am, however, pleased to say that the arrangement works with perfect smoothness and comfort; and, if any difference exists in the time occupied in the work, it is in favour of the new arrangement. This retort-house is designed for the adoption of machinery at any time in the future it may be considered desirable to provide it; and, when that is done, neither coal nor coke will be touched by the shovel from the time the coal arrives from the colliery until the coke is received in the truck at the place where it is to be finally consumed.

The question of condensation is one that merits, but does not always obtain, the amount of attention that its importance demands. By condensation, the whole influence of temperature on the gas between the retorts and the holder should be

considered. The action of the hydraulic and foul mains in this respect has been brought prominently before the Association by our Secretary and others; but it is most important that the influence of the other plant—such as scrubbers and washers, and even purifiers—should be taken carefully into consideration. My attention was called to this matter from the rapid growth of the same works I previously referred to, which, when first started about twelve years since, had an annual make of about 50 million cubic feet, but now has reached a make about treble that quantity. It will, of course, be obvious that extensions of plant have been necessary to meet increased requirements; the only part of the works untouched being the condensers. These are of the annular type, 2 ft. 8 in. in diameter, with a surface area of 1828 superficial feet; but the whole of this is not even now used in winter, as the central tube in one of the four columns is stopped—it being found that, with the lower scrubbers and washer, the condensation was quite rapid enough, even when the make was greatest, and during the severe frost, the temperature of the condensers was raised by steam-pipes fixed temporarily. In Newbigging's "Handbook," the capacity for air condensers is given as from 5 to 10 superficial feet of condensing area for every 1000 cubic feet of gas per 24 hours of maximum make; while the capacity we have is not quite 3 feet, and, as we have provision for increasing the number of retorts, of course the proportion will be still less.

In looking into this matter, the temperatures were taken at various points; and the following table will illustrate my meaning. It shows the effect of outside temperature varying from 20° to 88° Fahr:

This illustration seems to point to the probability that, in many cases, the open air condensers are frequently too large altogether, or at any rate in winter, and that increased length and area would be desirable in the foul main, and provision for reducing the area of the outside condensers in cold weather, in order to ensure more uniform results.

So much has been written and said on the question of purification recently, that the only allusion I shall make to the subject is to ask if the restrictions imposed as to the presence of sulphur in minute quantities is of sufficient disadvantage that the expense of its removal is worth to the consumer the amount of the additional cost of the gas. This question is finding a place in many minds, and has found an audible voice in the Bill promoted by the Crystal Palace Gas Company, who are asking for the limit to be 30 grains per 100 cubic feet, instead of

17 and 22 grains. If this question can be raised in a district like that served by the Company referred to, with important residential areas, how much more unnecessary do the restrictions appear in the case of poor or manufacturing neighbourhoods or cheap business quarters, where so much gas is used for outside lighting, cooking, motive power, or manufacturing and industrial processes.

Table of Temperatures—Condensation of Coal Gas.

Outside Tem.	Foul Mains.		Condensers.			Scrubbers.				Washer.		Meter.
	No. 1.	No. 2.	Inlet.	No. 3.	Outlet.	Inlet. No. 1.	Outlet. No. 1.	Inlet. No. 2.	Outlet. No. 2.	Inlet.	Outlet.	Inlet.
Fahr.	Fahr.	Fahr.	Fahr.	Fahr.	Fahr.	Fahr.	Fahr.	Fahr.	Fahr.	Fahr.	Fahr.	Fahr.
20°	—	100°	90°	70°	58°	66°	52°	52°	46°	54°	32°	43°
22	—	98	90	68	58	66	52	52	46	66	34	42
28	—	100	94	80	64	66	52	52	44	68	44	42
30	—	110	100	84	76	74	54	54	46	68	44	42
32	—	116	100	86	82	82	62	62	50	70	52	46
34	—	122	106	90	86	84	64	64	52	70	50	44
36	—	120	108	90	88	88	66	66	54	54	40	44
38	—	122	114	92	80	82	64	66	56	56	44	46
40	114°	108	104	88	76	82	72	74	66	70	56	54
42	116	112	106	84	70	78	64	66	58	66	54	58
44	118	110	102	78	64	73	58	61	54	58	46	51
46	115	112	106	85	70	77	66	68	61	68	54	61
48	104	95	86	62	52	64	51	56	47	53	44	52
50	135	130	120	90	76	82	66	68	62	66	56	58
54	130	120	112	86	74	80	68	70	64	70	62	59
58	116	112	104	87	73	86	67	70	63	66	58	60
60	124	120	112	96	84	88	76	78	70	74	64	62
64	128	122	104	80	67	78	68	72	66	70	64	62
68	106	106	96	79	66	78	66	68	62	65	56	64
70	130	120	108	84	70	80	70	72	70	73	63	62
72	126	126	111	96	87	90	78	81	78	80	74	65
74	124	123	110	80	70	76	70	72	70	70	68	65
76	124	122	115	92	84	87	80	83	82	84	74	65
78	124	122	113	92	81	17	79	82	76	79	82	64
80	122	122	119	104	95	93	86	88	88	87	81	64
84	132	132	120	113	95	96	86	88	83	85	79	69
86	135	132	118	100	90	92	85	84	86	88	81	67
88	132	132	120	113	95	95	86	88	83	85	79	69

With reference to the subject of gasholder construction, it may be interesting to members to mention that the two-lift holder erected by this Company at their Swindon Gas-Works about three years ago, with guide-framing to the lower lift only, has given no trouble whatever; and its behaviour in the roughest weather is ample evidence as to its stability.

In the consumption of gas, the field of useful application is a very large one. A convenient arrangement for warming meter and governor houses in very small works where no steam was available, we have found to be a very simple gas-heated boiler, with circulating-pipes. This, with a small consumption of gas, has proved to be an excellent precaution against frost, with the

minimum of attention or labour. In the important department of this Company which is under the control and direction of Mr. Dean, of Swindon—I mean the Locomotive and Carriage Department (of which the Gas Department is only a very small section)—not only at Swindon, but over the whole system, which embraces the greatest extent of mileage of any railway in the kingdom, gas is made to do useful service in many quiet and unsuspected places. The water-cranes, which are so exposed to the influence of frost in severe weather, are frequently, where gas is available, kept from freezing by jets in out-of-the-way places underneath. Gas also is a useful servant in burning off paint; in providing clean and steady fires for lamp makers and tinmen; in heating tyre-furnaces, not only for taking off and putting on carriage and waggon tyres, but the large and heavy locomotive tyres up to 8 feet diameter; rivet-heating furnaces, and various applications of the Bunsen burner, are found rendering useful service in various departments; while, in the foundry of our large works at Swindon, the core-drying ovens, 24 feet in length, are heated by an arrangement of gas-burners, which takes the place of furnaces and heating flues—the principal advantages being the greater facility for obtaining an entirely uniform temperature, the saving of labour attending to furnaces, as well as of labour and material for the repairs and maintenance of the same. Gas-engines are also beginning to take their place alongside the steam-engine in the provision of motive power.

In oil-gas manufacture, this Company, in common with most of the leading railways of the country, are rapidly increasing their provision for the manufacture, compression, and storeage of oil gas at various selected stations on their system, in order to provide for the supply of the constantly growing number of carriages fitted with gas apparatus and lamps. A variety of burners are also receiving attention; and the mushroom-shaped regenerative burner is competing for a share of the public favour with its formidable flat-flame rival. On the Continent of Europe, in America, and India, oil gas train lighting is already making considerable progress; and with the facilities of intercourse now existing, we may be sure that Australasia and even Africa will soon follow.

In the field of general lighting, great possibilities are opened up in the study and investigation of substances and appliances for incandescent gas lighting. Mr. H. Leicester Greville, in his most suggestive paper published in the *Journal of Gas Lighting* for Jan. 24 last, points out that the high result obtained in testing

the Welsbach lamp, was given equally when the normal illuminating power of the gas was reduced to about one-third its original value; and if we are to compete with the prophesied full development of electric lighting which Mr. W. H. Preece announces is to equal gas at 2d. per 1000 cubic feet, it seems to me this is, as far as present indications allow us to judge, the direction in which we must look. The competition in regenerative high-power lamps will tend to lessen their cost, develop further improvements, and bring them more within the reach of ordinary consumers.

Turning aside from appliances either for the manufacture or consumption of gas to the relationship between the gas companies and their managers, and the men they employ, I think the gas industry, as well as the manufacturing world generally, have been laid under a deep debt of gratitude to Mr. George Livesey by the battle fought and won for the right of employers to freedom of arrangement with their own men without outside intimidation or dictation, while at the same time he has been labouring, by statesmanlike measures, to bring about permanently improved relationship between the workers and those they serve, by giving them a personal financial interest in the success of the undertaking in which they are engaged. This is not only useful in removing friction and promoting good feeling, but is a practical devolopment of a principle that seems to afford the most valuable and satisfactory common ground of interest for capital and labour; and in the spirit of unrest that obtains in many quarters, and the influence that can now be brought to bear upon legislation by the rank and file of labour, this great plan of profit-sharing, built on the foundation of community of interest and mutual benefit, appears to point the way to amicable and satisfactory lines on which many of the labour problems of the future may be solved, and without aiming at the impossible Utopia of clever writers like the author of "Looking Backward," a state of things may be realized in which even the humblest toiler will have some proportional share in the prosperity of the undertaking in which he is engaged. The more this principle can be carried out in the industrial world, the greater the probability of avoiding the rude and objectionable form of contest, unfortunately familiar under the term "strike," which could, with advantage to all, be relegated to the pages of history along with the feudal system of past ages.

Ever since I have had any opportunity of knowing anything of the working of the various Institutions and Associations connected with the gas-making interests of the country, I have

been much impressed with the view that there is a want of general co-operation for practical purposes in the interests of progressive development, and a lack of that united concentration of experience and ability, for purposes of research or recommendation in reference to new processes and appliances, which ought certainly to be available. Briefly, what I think is needed, and is within the possibilities of practical politics, is a federation of the various societies on some basis which will practically leave untouched the organization and control of each separate Association, but provide a central representative body formed of chosen representatives from each, which will necessarily be the natural and official voice of the gas manufacturing interest and skill of the country, and shall be able to provide such a powerful Committee of Research or Reference that to them subjects which the industry at large would desire to see more fully investigated might be referred—such as the relative value and cost of ordinary and regenerative firing, of various types of retorts and settings, of air and oxygen purification, of various classes of lamps and burners, the standard light unit, and the existing regulations governing the quality and manufacture of gas.

I fear this simple fact is lost sight of—that, by far the majority of gas undertakings are, after all, what would be called small; and in these the directors, committee, engineers, or managers have not the power or opportunity of spending large amounts in experiments. They naturally choose a policy of waiting rather than attempt what might be regarded as a doubtful experiment, which might possibly interfere with the power of paying the usual dividend; and even when perhaps a majority in the management were prepared to take a new departure in the provision of more modern plant or recent development of some new system of working, the conflicting statements of the promoters of rival firms interested in the working of the new method or plant, so perplex and confuse, that the result is a rejection of both. If, in circumstances of this kind, the disputed question had been before the Research or Investigation Committee of the Council of the Federated Gas Associations, the report of such a Committee would be a guide that, amid the babel of conflicting opinions, would be respectfully esteemed, and regarded as a counsel of safety. I am satisfied that new and improved methods and appliances would be adopted with greater rapidity, and with more general advantage to the industry at large, under a system such as I have sketched. In addition, what I may venture to call partial discoveries might be

followed up, and reliable data obtained as to the value or possibility of the new appliance or method, without the loss of time to the country in waiting for someone or other to find time or opportunity to take the matter further.

I have not taken up this subject without some practical acquaintance with the possibilities of federated usefulness, as, in another sphere of associated effort, I know a federation of associations differing very widely indeed in their constitution, organization, and methods of work, and yet having one general underlying agreement. They are by this means able to meet and carry out many matters of general interest that could not be dealt with by individual associations, and also formulate recommendations and give expressions of opinion that are generally valued and usually gladly acted upon; and this knowledge makes me hopeful that the gas industry may yet be able to move on the same lines. The desirability of this has been referred to on many occasions by Presidents and members of our various Associations. Our last President (Mr. Irving) urged its importance; and Mr. C. C. Carpenter, at the last Southern meeting [*ante*, p. 14], alluded to a paper on the subject read by Mr. Addicks, of the American Gaslight Association, and suggested that we might take "the wind out of the sails" of our Yankee brethren by bringing about a federation in this year of grace 1893. As a practical step, the Committee of this Association have decided to bring before you two resolutions that will be submitted by Mr. Irving, which I trust will receive the friendly support not only of this meeting, but also that of other Associations. The scheme so drafted is to be sent to each society or Association for its consideration, amendment, or approval. If this scheme is received and considered generally with a sincere desire for united action, there need be no real barrier; and at any rate the year 1894 would witness this welcome addition to our usefulness, and a greater sympathy and unity obtaining among the gas engineers and corporations of the country.

I would now bring my remarks to a close by giving a few particulars as to the oil gas-works you have just been inspecting. When the Great Western Railway Company decided to commence the manufacture of oil gas, the battle was raging between the Pintsch and Pope systems; and, like the London and North-Western Railway Company, the Directors obtained their first plant from Messrs. Pope and Son, of Slough. This firm erected a bench of 6-inch cast-iron ⌂ retorts, 4-inch pipe condensers, a 2 ft. 6 in. brick scrubber, a small low-pressure gasholder of 1000 cubic feet capacity, and four high-pressure

reservoirs of 270 cubic feet capacity each, or a total of 1080 cubic feet. By the year 1887, the make of gas averaged over 40,000 cubic feet per week, and occasionally reaching 60,000 cubic feet per week. At this time the consumption began to increase at a rapid rate; and extensions had to be made, in order to provide the increased quantity required. A new bench of retorts was built; and the size was increased to 8 inches, and the length increased by 1 foot. The old bench was then pulled down; and two new benches of 8-inch retorts erected, providing 18 pairs of retorts in all. New cast-iron condensers consisting of five hollow cast-iron columns, 18 inches diameter, standing over a long brick and cement seal tank, an additional dry scrubber, 4 feet diameter and an additional holder of 2000 cubic feet capacity, also nine more high-pressure reservoirs have been fixed, giving an increase of 2430 cubic feet storeage for high-pressure gas. We are now preparing to fix a reservoir over 7 feet diameter by 25 feet long over all, and 920 cubic feet normal capacity.

The compressing has hitherto been effected by three engines of the type originally made by Messrs. Pope and Son, with 6-inch pumps and 10-inch steam cylinders, 16-inch stroke. These compressors are now being replaced by larger and more powerful engines made at Swindon under the direction of the Chief Engineer (Mr. W. Dean). The pumps are 9 inches in diameter, and the steam cylinders 15 inches diameter, with 24-inch stroke.

The gas is conveyed by mains $\frac{7}{8}$ inch inside diameter through the various sidings and carriage-sheds at West London, where the trains are cleaned, gassed, and formed ready for use, and are already laid about half the way to Paddington Station for supplying various sidings, &c., *en route;* ground or filling valves being provided at all points considered necessary. The hydrocarbon deposited during the compression of the gas is of a very inflammable nature, and flashes at ordinary temperatures. In order to ensure safety in dealing with this, a small tank, of the same strength as the high-pressure reservoirs, is placed underground, into which the hydrocarbon from the reservoirs is drawn as required; and when it has to be filled into iron drums for despatch, it is conveyed some distance in a pipe laid underground to a shallow brick pit, where the drums stand for filling. This work is only done in daylight. The storeage and handling arrangements are under the licence and approval of the Inspector of the London County Council. The make of gas about last Christmas time nearly reached 300,000 cubic

feet, consuming over 4000 gallons of oil. Our oil supply is kept in tanks underground; and we have storeage for 7000 gallons.

The fuel used for heating the retorts is coal. The only product in the manufacture of oil gas, besides the hydrocarbon is the tar, which is not a generally marketable commodity. We have, therefore, adopted the plan of burning it for fuel, with a steam spray injector, which answers our purpose very well. We have had one special difficulty to contend with, which, in the recent stringent regulations adopted by many local authorities, other manufacturers of oil, or even coal gas, may have to face. We received complaints of nuisance from smell arising from the drains, into which the drainage from the gas-works was delivered, and were called upon to make our effluent water absolutely inodorous, or deal with the matter in some other way. I will not dwell upon the various schemes that were considered, such as filter-beds, settling-tanks, &c.; but eventually an arrangement was adopted which has met with the approval of the local authorities and has enabled us to deal entirely with our own drainage water, and absolutely sever and concrete up our connection with the London drainage system. Our arrangement is this: Two large iron cylinders or tanks have been sunk into the ground, side by side, into one of which the drainage is allowed to run. About 4 feet from the bottom is a pipe connecting the two cylinders together; so that, when the water is 4 feet deep in the first cylinder into which the drainage flows, it runs into the other cylinder in which the suction-pipe of the steam-pump is placed. An overhead tank, in two divisions to allow for cleaning, is also provided some distance away; and, at regular periods as may be required, according to circumstances, the pumps are set to work, and the drainage water is delivered into the high-level tank, which it reaches by an open trough channel, so as to obtain the assistance of the oxidizing action of the atmosphere. On reaching the tank, this water is mixed with an additional supply, to make up for what is used by evaporation in the steam-boilers of the works; but the smell is neutralized by the addition of finely-crushed permanganate of potash, placed in equal proportions in each of the cylinders and tanks, with the result that, at comparatively small cost, we have succeeded in overcoming what seemed a serious difficulty, and been enabled to comply with what many would consider unnecessarily harsh and stringent regulations. At any rate, we have found a way to meet the high standard of efficiency which is being demanded of manufacturers in the avoidance of nuisance, or of anything

tending to interfere with the comfort and efficiency of the modern systems of sanitary science and hygienic conditions of life; and I think that, with the tendency of the times, any improvement that can be made in this direction is worth the attention of gas manufacturers, as well as managers of any other works, against which a charge of nuisance can possibly lie.

I trust that the further opportunities we are to be privileged with in the way of inspection of a modern works, with many specialities in plant and methods, may be found exceedingly interesting and instructive.

Mr. D. IRVING (Bristol) said he had great pleasure in proposing that the thanks of the members be given to the President for his address. It was a record of his own experience and daily observation; and these were the things which it was necessary they should discuss when they met.

Mr. DURKIN seconded the motion, which was carried.

The PRESIDENT, in reply, said he had some difficulty in knowing what ground to take when he found the addresses of Presidents of other Associations coming out so rapidly. He therefore fell back upon items of his own experience, which, he thought, might have a little usefulness and freshness as being slightly different to ordinary practice.

FEDERATION OF GAS MANAGERS' ASSOCIATIONS.

Mr. IRVING then introduced the above subject for discussion, by formally moving two resolutions which had been unanimously adopted by the Committee. Perhaps, he said, he ought to preface his remarks by saying, that, as far as he was concerned, no one had been consulted in the action that had been taken who was officially connected with The Gas Institute or the Institution of Gas Engineers. The first resolution was: "That this Association approve of the formation of a federation of the various District Associations, together with The Gas Institute and the Institution of Gas Engineers." The second resolution was one which practically sought to carry into effect the idea contained in the first. It was as follows: "That this Association cordially invites the several District Associations to appoint two representatives each, and The Gas Institute and the Institution of Gas Engineers four representatives each, to meet in conference at a meeting to be called in London in August or September next." Their President had so ably presented some of his (Mr. Irving's) arguments in favour of federation that it was scarcely necessary for him to take up the time of the members. He might, however, say the idea had engaged

the minds of many thoughtful men for some time past. The President had mentioned in his address that the question was before the South-West Association on a previous occasion, and that Mr. Carpenter had very warmly expressed his approval of federation in his address to the members of the Southern Association at their last meeting. As to the value of Associations of Gas Engineers and Managers, the opportunities they afforded for the exchange of ideas and experience, and the various contributions they had brought together year after year in their transactions, had been of the greatest advantage to the profession, and of great profit to the industry. The resolutions which he asked the members to pass (and which, as he had already said, had been unanimously endorsed by the Committee) sought to strengthen, by combining and consolidating, these various Associations. At the present time, there were eight District Associations, with a membership of 760, The Gas Institute with its 554, and the Institution of Gas Engineers with a roll of 118 members—these figures, of course, including associates, &c. Yet not one of these societies could be fairly said to be representative of the British gas industry, nor had they any connecting link or any means of organizing the combined influence and opinions of those engaged in this great industry. They did not, in the first place, propose, or even venture to draft, the foundations of this suggested combination, but now simply set in motion what they believed would be a thoroughly representative Committee, which, they trusted, would loyally devote itself to the elaboration of a constitution that would be satisfactory to all reasonable men. Doubtless, they would be told this was impossible. Their answer to this was that at any rate they meant to make an honest endeavour; and, while fully mindful of the delicate and difficult task they would have in bringing about the accomplishment of this federation, some of them at any rate felt satisfied that, if they could only get the Committee together, they might depend upon the wisdom and the good sense of the profession generally, to support any scheme that could be shown to be for the common good of the profession and in the interests of the gas industry. There was, he believed, a general opinion outside that they had too many meetings; and this was doubtless produced by the number of Associations that existed. He had in mind one gas company, some of the responsible officials of which were connected with The Gas Institute, some with the Institution of Gas Engineers, and others with District Associations. In such cases as this

it appeared to outsiders that, from April to September, they had a sort of monthly meeting; and so the Associations lost some of their legitimate weight and influence. Besides this, he thought there was considerable waste of time, energy, and money in running rival institutions. Every thoughtful man knew there were scores of problems in their daily occupations in the manufacture of gas that wanted elucidating and needed investigation. They were surrounded with opponents in the electric light, cheap oil, and strong labour combinations; and there could be no doubt that, in the natural progress of things, the electric light at least would become more powerful. He now ventured to say that, instead of running rival institutions, they would be better employed in seeking to cheapen or improve the manufacture of gas. There could be no doubt that, in these rival institutions, one could only succeed at the expense of the other; and the Committee of the South-West Association were hopeful enough to think that, if they could only get a representative Committee together, that of itself would be a good step towards the object in view—the reunion and federation of all the Associations. A national federation, having the entire support of the profession, would naturally receive the confidence and support of corporations and companies owning gas undertakings; and if the federation could show it was doing useful work, there would be no difficulty in obtaining means for carrying on all profitable investigation. Thus a large national representative organization would command not only respect and confidence, but would be promoting good feeling and brotherhood, which would be far more profitable in these busy days than in spending their energy, time, and money in generating disunion and bad feeling. No doubt a great deal more might be said in favour of these resolutions; but there was only one other suggestion he wished at this stage to make, and that was that it was very desirable no expressions should be made in this discussion which would be likely, even in the slightest degree, to give offence, or make future negotiations difficult, or probably impossible. It would be well to begin with a kindly consideration for everyone, as far as possible.

The PRESIDENT said he had referred to this subject in his address without any idea of what was in Mr. Irving's mind. Before the question was introduced at the meeting of the Committee, he had put his remarks on paper in rough form; and he had therefore much pleasure in seconding the resolutions. He noticed that Mr. Carpenter, the President of the Southern Association, was with them; and as he had already expressed

himself with reference to this matter, they would be pleased to hear a few words from him.

Mr. C. C. CARPENTER (Vauxhall) observed that his position was somewhat awkward, since he was present at the meeting in the capacity of a guest, and not as one of the members of the Association; and it would perhaps seem that he had no right to state there any opinions he might have on the subject, although the President had kindly given him permission to do so. That the existing order of things was quite wrong, there could be no two words. They might very well liken the position of the Associations to the condition of affairs that had existed in London before the districting arrangements came about. At that time they had several companies, with two or three sets of mains in the same streets, all seeking for customers; and in the gas industry they had now a very similar state of things—there was no national organization such as had been sketched out, but several, which could not combine in the best way the knowledge that was requisite to deal with the many subjects which were constantly coming up for discussion. He was sure, if the South-West Association were able to bring about such a federation as had been described, they would earn the thanks of the gas industry.

Mr. H. WIMHURST (Sleaford), the Secretary of the Eastern Counties Association, who was next invited by the President to address the meeting, could only say that, when the question came before his Association, he should have much pleasure in personally urging the Committee to give it all the support it deserved; and, being a member of the Council of The Gas Institute, he thought he could vouch for the same consideration from that body.

Mr. N. H. HUMPHRYS stated that he was strongly in favour of this proposed attempt at federation, for several reasons. For one thing, he thought it presented to them a means of bringing about a great saving of time and some saving of money. There were many present who were members of more than one Association, and who were paying subscriptions amounting to two or three guineas a year; but if a subscription of (say) two guineas a year were confined to one Association, he believed it would produce greater results than under the present condition of things. He had some sympathy with Mr. Irving in regard to the number of meetings that one was called upon to attend in the course of the year. In order to get away from home that day, he had to account for the existence of so many Associations. When he asked permission to come, he was reminded

that he was away all day on the previous Saturday at a meeting in connection with The Gas Institute; and one day recently he was at the Southern Association meeting. It was then suggested that it would be a good thing if all the Associations could be made into one; so that he had come to the meeting in some measure prepared to hear the views that had emanated from previous speakers. As to the reference which had been made to the American Associations, they appeared to be in the same position as themselves—there was a large amount of machinery set to work, and the result was not adequate to the expenditure of time and money; and a combination or federation might do a great deal more useful work for the members and the profession at large. Something had been said about rivalry; and (he said it in the utmost friendly spirit—he was perfectly independent himself) it was no use denying that there had been a certain amount of party spirit. They did not want anything of that sort in the gas engineering profession. Anything like that must tend, not to assist and stimulate, but to hinder, progress. In another way they had been rather unfortunate in gas engineering—that was, they had no men of leisure as in other professions. In the Society of Chemical Industry and the Institution of Civil Engineers, they had men who had made money, and had a great deal of leisure on their hands, which they devoted to the advancement of the societies they represented. They had no one to take the place of these gentlemen in the gas industry; so that this was another reason why they should gain as much as they could from their Associations, which undoubtedly were giving the members good work and a great deal of benefit, but they ought to get this at the least possible cost of time and money.

The resolutions were then put to the meeting, and carried unanimously.

On the motion of Mr. LOWE, seconded by Mr. H. SAINSBURY (Trowbridge), the President and Mr. Irving were afterwards appointed to act as representatives of the Association at the proposed conference; but both these gentlemen expressed their willingness to retire in favour of Mr. Humphrys, if he was not connected with the conference in some other capacity.

Mr. W. STAGG (Bristol) next read the following paper:—

NOTES ON THE MANUFACTURE OF GAS.

The following notes on the manufacture of gas are, to some extent, a record of attempts made to promote efficiency and

economy of working. Being at one time worried by the frequency with which the sealing liquid in the hydraulic main was reduced to the point at which gas of abnormally low illuminating power was brought over (no less than thirteen times in one month), I determined to satisfy myself as to the cause. It was suggested to me that this was due either to leaky bridge-valves or to the fact that in some way the tar and liquor syphoned themselves out of the hydraulic main. Neither explanation sufficed for me. The fitful and capricious manner of its occurrence, first in one hydraulic main and then in another, disposed of the theory that it was owing to leaky valves; and a consideration of the facts satisfied me that it was not syphoned out. Close observation convinces me that, in nine cases out of ten, it is attributable to evaporation. I thought perhaps the partial vacuum due to the pull of the exhauster might aggravate the evil; but I am sure this has little to do with it. The boiling-point of tar and liquor is somewhere about 212° Fahr., while the temperature of the gas in the ascension-pipe I found ranged from 120° to beyond 360° Fahr. During the earlier hours of carbonizing a charge, the gas would be *saturated* with vapours; but later on the dry unsaturated gas would certainly tend to diminish the seal. Still this explanation as to the active cause breaks down unless it can be shown to occur with some approach to regularity.

To satisfy myself that the reduction of the seal was due to evaporation, I drew some of the hot gas direct from the ascension-pipe through a sample of liquor from the hydraulic main contained in a flask provided with a thermometer. The thermometer registered 104° Fahr. After passing the gas for one hour, I found there was no reduction in the quantity. Thinking this low temperature resulted from atmospheric cooling through the thin glass, I refilled the flask, and inserted it inside the ascension-pipe, and again caused the gas to bubble through in the manner shown on the sketch at A (fig. 2.) In one hour all had disappeared. I withdrew it next time after an exposure of only 10 minutes, with a like result. I then made a similar test on tar. After an hour, 19 per cent. had been vaporized; leaving as a residue a plastic pitchy solid. There is little doubt that much less than an hour would suffice for this result. Then came the question: "Why should the seal be preserved for days and weeks, and then suddenly become reduced?" I purposely lowered the seal in the hydraulic main very slightly on one side only of a bench; taking care to keep it up on the opposite side. In 35 minutes, the temperature of the gas on the lower side rose

180°—viz., from 170° to the limit of the thermometer (350), which I then removed for fear of fracturing it; while on the side of the normal seal, the temperature steadily fell.

Let us suppose that on one side of a bench of retorts you have careful stokers who clear out the ascension-pipes properly after each drawing, but on the opposite side of the same bench you have careless ones who neglect this duty. The bulk of the gas will, of course, take the course of least resistance; and a disproportionate quantity will pass off through the hydraulic main on the side of the clear ascension-pipes. The temperature here will rise correspondingly, and set up a rapid evaporation. Then, having once started to lower the seal, the ratio of

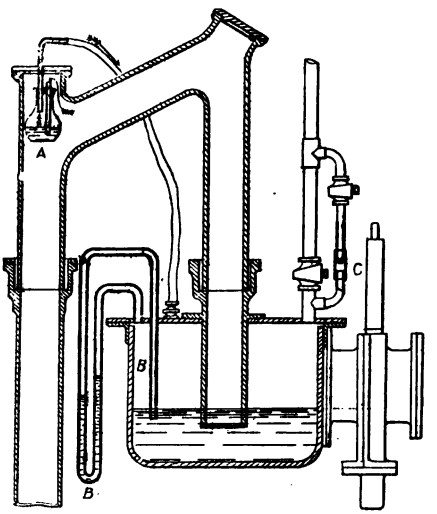


FIG. 2.—APPLIANCES FOR TESTING SEAL IN HYDRAULIC MAINS.

the quantity of gas passing on the side of the reduced seal rapidly increases, with a consequent rise in temperature, until the bottom of the dip-pipe is entirely freed by evaporation, and you arrive at the critical point when air and furnace gases are brought over, to the serious detriment of the illuminating power of the gas. I devised a gauge to indicate the approach of this critical point. It is shown at B on the above diagram. An ordinary pressure-gauge has one limb connected to the cover of the hydraulic main, while the limb which is usually open to the air is in communication with a pipe passing through the cover of the hydraulic main, and dipping about an inch below the normal level of the seal. While the bottom of this pipe is itself sealed

in the liquid, the gauge records the amount of exhaust in the hydraulic main; but should the level of the sealing liquid in the main be lowered, the gauge *gradually* becomes level.

Such a gauge as this would certainly prove useful in small works; but its application is out of the question where there are 20 or 30 hydraulic mains in action. What, then, is the remedy for this "black beast" of the gas manager, which has a knack of turning up at most inopportune moments? An undoubtedly successful remedy is to provide an artificial supply of liquor. For this purpose, a constant stream from a nipple with only ⅛-inch hole is sufficient to compensate for the evaporation in a hydraulic main receiving gas from 40 retorts. Its chief value consists, I think, in preventing the lowering of the seal at its initial stage. I have made a sketch (shown at C) of this arrangement, which provides a 1-inch supply-pipe to refill the main in case of accident. Finding it essential that the tank supplying this liquor service should not be allowed to run out, I have connected an ordinary 24-inch pressure-gauge to the delivery of the pump, to keep the attendant informed; the indicating fluid being mercury instead of water.

I have recently made a number of tests to ascertain what advantage, if any, would accrue from the proposal to remove the tar from the hydraulic main, and seal the dip-pipes wholly in liquor. That a liquor seal can be maintained, I have proved beyond doubt, when the syphon for the removal of the tar is used in connection with this continuous liquor supply. With the overflow of the syphon half an inch below the normal level of the seal, it is possible to maintain *continuously* in the hydraulic main a surface layer, four or five inches deep, of liquor unmixed with tar for months together. To ascertain the value of such a seal of liquor over tar, I made some tests upon the illuminating power of gas before and after bubbling through tar and also through liquor. The effect of liquor upon the gas was simply *nil*. The tar, on the contrary, reduced the illuminating power in all cases, until the temperature of the tar was artificially raised to 150° Fahr., when the gas was slightly enriched. This enrichment would be due to the distillation of the richer hydrocarbons, which the tar at lower temperatures absorbed from the gas. In actual working, these illuminants would have been removed to the tar-well during the earlier stage of carbonizing off the charge, and thus lost to the gas.

In seeking for confirmation of the advantage of a liquor seal in practical working, candour compels me to admit that I have not found any; although I am certain that the tar has not

been within two or three inches of the bottom of the dip-pipe. I had exceptional opportunity for making the test in a setting of eight 20-feet through retorts, carbonizing 8 tons of coal in twenty-four hours, provided with a separate exhauster, purifying plant, and meter. The coal was accurately weighed in, and a twenty-four hours' test made, first with a liquor seal, then with a seal of ordinary character. The difficulty of being certain that the quality of the coal was the same each day may perhaps introduce an element of uncertainty; but to me it is significant that in all cases the best results were given when working in the ordinary way, with a seal of tar and liquor; and this from each kind of coal and cannel tested upon. It may be alternate tests of twenty-four hours are unsatisfactory. Still, one would think that the retorts having carbonized off four charges for each test, the result would be conclusive.

I should like to say a word in favour of controlling the illuminating power of the gas at the exhauster. A jet photometer, with its own small purifier (standardized *in situ*, once at least every twenty-four hours) connected immediately with the outlet of the exhauster, enables the attendant to observe the earliest possible indication of a change in the quality of the gas coming over, and to deal with it directly and effectively. Barring accidents, it is possible with this arrangement to make gas of approximately constant quality. I am sure it is impossible to over-rate the value of this method from an economical point of view, whether considered from the saving of foreman's time, or in avoiding the waste resulting from making gas of a higher illuminating power than is required. Any lowering of the seal in the hydraulic main is at once observed, by the consequent abnormally low illuminating power indicated; whereas, when the quality is regulated at the end of the process of works' purification, the whole of the plant is filled with gas of low illuminating power before its discovery, and hours of low driving are often required before the gas again attains the standard illuminating power.

It is essential that the jet photometer should record correctly; and frequent adjustment is therefore necessary, to compensate for changes in temperature, in atmospheric pressure, and in the specific gravity of the gas. Undoubtedly, this adjustment is best done *in situ*, and can be readily accomplished by having a connection made with the gas tested at the bar photometer. I consider the practice of raising or lowering the water-line, in order to standardize the jet, an objectionable one. When the jet photometer registers too low, the hole in the burner can be

readily enlarged. Should it, however, be already too large, a difficulty arises. I have tried plaster of Paris for the purpose of reducing the hole, but not with any measure of success. I have sketched an arrangement (fig. 3) which occurred to me, and which has proved most satisfactory. The adjustment is made by raising or lowering a needle placed inside the burner tip. With this method of adjustment, the pointer should always return to zero when the gas is shut off—thus enabling the foreman at all times to check the water-line.

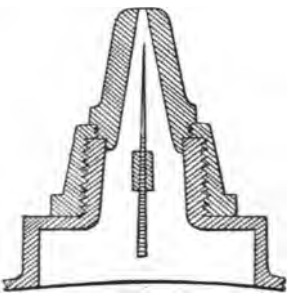
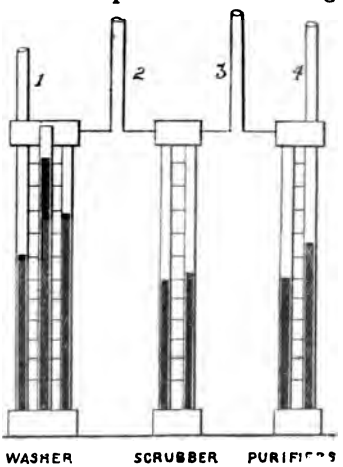


FIG. 3.—APPLIANCE FOR REDUCING THE APERTURE IN THE PHOTOMETER BURNER.

In fixing works' pressure-gauges, as far as possible each should be arranged to indicate to a passing eye the actual *resistance* given. Thus, a washer would be provided with a single gauge combining the inlet and outlet pressures, as is now frequently done with station meters; and the inlet and outlet pressures at the centre-valve thus combined would indicate the total resistance given by a set of purifiers. I believe, with gauges arranged in this manner, a much less frequent booking of pressures will be rendered necessary, the working condition be visible at a glance, and the foreman be set free to give more attention to the paramount duties of the retort-house. I have sketched such an arrangement (fig. 4, next page); and would draw your attention to the left-hand gauge, which has been designed with the object of showing, in addition, the total pressure at the outlet of the exhauster. This appears to me to be necessary, in view of accidentally approaching the maximum pressure covered by the seal in the lutes of the purifiers. For myself, I prefer gauges constructed with a sliding scale—the zero being at the bottom of the scale. Having placed this on the lower water-line, the pressure or resistance can be read right off in a straightforward manner.

Let me add a few notes on the use of carburine (sp. gr. 68) as

an enriching agent, instead of cannel. After six months' working with one of Mr. Clark's carburettors, without a single failure, I cannot speak too highly of the system. To enrich gas one candle requires 1¾ gallons of carburine per 10,000 cubic feet of gas. The gas carries the carburine perfectly at ordinary temperatures; and there is no deposit even at freezing-point.



1. Inlet to washer. 2. Inlet to scrubber.
3. Inlet to purifiers. 4. Outlet of purifiers.

FIG. 4.—STAGG'S ARRANGEMENT OF PRESSURE-GAUGES.

A series of tests were made with gas carrying 2¼ gallons per ton of coal, to determine the effect of cold. The carburetted gas was passing for eight hours through a series of U-tubes, immersed first in ice and then in a mixture of ice and salt, giving 20° of frost. As it was necessary that the water vapour present in the gas should be previously removed, calcium chloride was used—this substance having no effect upon the carburine. At freezing-point, the U-tubes were found perfectly dry, after the gas had been passing for eight hours. In the freezing mixture, there was a considerable deposit—probably one-third of the carburine in the gas was thrown down; but, under this condition, common and cannel gas condense out valuable illuminants, so that we are no worse off in this respect than we should be when using cannel. Gas containing carburine is found to absorb naphthalene more readily than common gas; but at freezing point this useful property fails entirely.

A series of tests have shown that the illuminating power of carburetted gas can be recorded perfectly with the jet photo-

meter. The working vapour tension of the carburine is 20 lbs. to the square inch; and ample contact with the heating surface should be allowed, in order to entirely prevent after-deposit. It is surprising how little steam the carburetter uses when it is arranged, as it can be, to discharge only the water of condensation. When managed in this way, the steam gives all its heat.

The question of cost will be determined by local considerations, and practically resolves itself into the difference between the extra cost of cannel over common coal against the cost of the carburine, because the quantity of vapour produced from the latter is not worth consideration. There is, I think, a point of economy in the use of carburine which should not be overlooked—viz., the facility with which the illuminating power of the gas can be maintained at the required standard, without the slightest risk of making and sending out better gas than is actually required. There need be absolutely no waste from this source. Starting with everything cold, four minutes suffice to raise the illuminating power of the gas 1, 2, or 3 candles, as may be required. Only a gas manager can know and feel what a boon this may prove at a critical moment; and I have no need to enlarge before the present company upon the value of such an auxiliary in the manufacture of gas.

Owing to want of time, it was agreed to postpone the discussion; and a vote of thanks was passed to Mr. Stagg.

Votes of Thanks.

The President remarked that the building in which they were then assembled was attached to the carriage works of the Great Western Railway. The room had been placed at their disposal by Mr. Dean and Mr. Armstrong; and he thought a hearty vote of thanks ought to be passed to those gentlemen for the facilities they had granted to the members of the Association that day.

Mr. White seconded the motion, which was carried.

The President said they ought also to record their thanks to the Directors of The Gaslight and Coke Company and to Mr. A. C. M'Minn, the Resident Engineer of the Kensal Green Gas-Works, for the permission which had been given to the Association to visit that station. He moved a formal resolution to that effect.

Mr. Irving seconded the motion, which was agreed to.

A vote of thanks was also passed to the President for his conduct of the proceedings.

Visit to the Kensal Green Gas-Works.*

The members and a number of friends were then conveyed by breaks to the Kensal Green Gas-Works, where they were welcomed by Mr. M'Minn. Before inspecting the works, the visitors assembled in one of the rooms attached to the offices, to receive from Mr. M'Minn a few general particulars concerning the plant. He said that the works were capable of turning out 10 million cubic feet of gas per day. In 1892, the total output was 1351 million cubic feet; and 125,000 tons of coal were carbonized. During the latter six months, however, 127 million cubic feet of oil gas were produced; and they used 3300 tons of coke, including what was used for the boilers, in the oil-gas manufacture. In No. 1 retort-house, they had 426 retorts, or 852 mouthpieces, capable of making 4 million cubic feet of gas in 24 hours. No. 2 retort-house contained inclined retorts—476 mouthpieces—which were equal to a production of 3 million cubic feet per day. With these inclined retorts, they found that there was a saving in labour of about 7½d. per ton of coal carbonized. By the oil-gas plant, they could now produce 3 million cubic feet of gas in 24 hours. There were six sets of oil-gas plant, each set consisting of a generator, carburetter, and superheater; and these three vessels were capable of turning out 500,000 cubic feet of gas a day. The cost of labour in connection with the oil-gas plant varied from about 2d. to 2½d. per 1000 cubic feet of gas made, according to the time of the year; and the cost per 1000 cubic feet of 18 to 20 candle gas was from 16d. to 20d. The saving in the number of men required to work this plant was very considerable, when compared with ordinary horizontal retort working—of course, excluding engine-drivers and pump-men in both cases. It took 36 men to work the whole of the oil-gas plant to make 3 million cubic feet of gas—that was, three shifts of twelve men—as against 138 men in the ordinary retort-house, or 46 men in each shift. This showed that 102 men less were needed in the case of the oil-gas plant to produce the same quantity of gas—being a saving of nearly 74 per cent. The new large gasholder had a capacity of 7½ million cubic feet. The tank was 250 feet in diameter; and 55 feet deep. The whole of the tank was constructed of Portland cement concrete, with thirteen tiers of hoop-iron

* A paper on the installation of inclined retorts and labour-saving appliances at these works was read by Mr. M'Minn before the Institution of Gas Engineers in 1891, and was given in the *Journal of Gas Lighting*, Vol. LVII., p. 941; and in Vol. LVIII., p. 309, an article appeared describing the locomotive steam-cranes in operation there.

bond built in. There were 2 feet of puddle at the back of the wall, the thickness of which at the bottom was 5 ft. 9 in., diminishing, by five offsets, to 3 ft. 3 in. at the top. The water capacity of the tank was about 11½ million gallons; and its cost was, in round figures, £41,000. The inlet and outlet pipes were of wrought iron, 48 inches in diameter. The holder was in three lifts, each having a capacity of 2½ million cubic feet. The total height of the standards was 165 feet. The rise of the crown was 18 feet. The strong plates were from $\frac{7}{16}$ in. to ¼ in. thick; and the main parts of the sheet weighed 5 lbs. to the square foot, or ⅛ inch thick. The cups were 1 ft. 9 in. deep. The cost of the holder was about £43,000; so that the total cost of holder and tank worked out to £11,419 per million cubic feet. The weight of the holder was 1095 tons; and of the framing, 1088 tons. In reply to questions, Mr. M'Minn said, with regard to the inclined retorts, they were not at present in action; but he might say that the actual saving in labour of the actual drawing and charging was very nearly what he anticipated it would be—viz., 7½d. per ton of coal carbonized. Before, however, anyone adopted inclined retorts, he should recommend them to put up a trial setting, and have a meter attached, so as to ascertain the quantity of gas produced per ton of coal. His settings were on the plan first introduced by M. Coze; and, of course, great improvements had been made in inclined retorts since then. He was bound to say he was not altogether satisfied with the results from these settings. There was a deterioration in the quality of the gas; and he was not at all pleased with the make of gas. As to endurance, they had not had to re-set any yet; but it was not so great certainly as in horizontal retorts. In his case the heats had been rather high; and, in fact, they had to be to burn the coal off thoroughly. In reply to Mr. Irving, he added that it would not be fair to judge inclined retorts entirely by the system worked at Kensal Green, as there was no doubt great improvements had been made. They had now been brought out with through mouthpieces, without the bends at the back, and so on; but he had not met anyone yet who could give definite figures as to the make of gas per ton of coal carbonized. He also mentioned that the coal conveyors and grabs answered very well indeed; and the cost of working was only 0·6d., as against 4d. previously. Mr. Stagg inquired what was the reason the inclined retorts did not give such good results per ton of coal as the horizontal ones; and, in reply, Mr. M'Minn said he believed that every class of coal had a certain angle at which it could distribute over the retorts.

One day they might be using fresh coal from South Yorkshire, dry and nutty, and, in a considerable percentage of the retorts, this would be distributed very evenly. Next day they might have to work Newcastle coal, which had been lying out in the open; and that would remain in the bends and the tops of the retorts. He believed that, with the improved inclined retorts, they must use coal of a uniform quality.

The visitors spent some time in inspecting the works; the oil-gas plant and the inclined retorts, of course, claiming most attention.

Before quitting the premises, the President, in the name of the Association, thanked Mr. M'Minn for the preliminary information he had given them, and for the trouble he had taken during the inspection to point out the most interesting features of the plant under his care.

This concluded the day's proceedings.

SCOTTISH GAS MANAGERS.

ANNUAL MEETING, APRIL 12.

The Tenth Annual "Informal" Meeting of Scottish Gas Managers was held in Glasgow, under the presidency of Mr. A. Wilson, Manager of the Corporation gas-works at Dawsholm and Temple Farm. The meeting was, as usual, convened by Mr. James M'Gilchrist, of Dumbarton; and there was a larger attendance than had been known for some years. This was doubtless due to the courtesy of Mr. W. Foulis, the Corporation Gas Engineer, in throwing open for inspection the works under his charge. Though Mr. Foulis gave a general invitation, Mr. M'Gilchrist felt that the time at the disposal of those who attended the meeting would not suffice for a visit to more than one works; and he selected those at Dawsholm. The wisdom of the decision lay in this—that, while the visitors were able to see the extensive additions in progress there, they also had the rare privilege of examining the new 6 million cubic feet gasholder which is in course of construction at the Temple Farm works adjoining. These works were acquired from the Partick, Hillhead, and Maryhill Gas Company; and as they were only separated from the Dawsholm works by the Forth and Clyde Canal, the Corporation had a tunnel constructed below the stream, in which to lay mains and provide ready access from one of the works to the other. The tunnel—about 150 yards long—had just been completed; and the visitors walked through it.

Visit to the Dawsholm and Temple Farm Gas-Works.

The company assembled at Macrae's Victoria Hotel, in West George Street; and, shortly after one o'clock, they took train by the underground railway to Maryhill Station, from which they entered the Dawsholm works by the private line serving them. As they passed in, they were shown the two holders to which the accident occurred in January, 1891, and which have long since been repaired and in use. Proceeding down the circuitous slope of the railway, they came upon a busy scene, where workmen were engaged in the erection of a

purifier-house and tar-well on a large scale. The work of constructing the purifiers alone, with the roof of the building, has been entrusted to Messrs. C. and W. Walker, of Donnington, at the contract price of £11,300. A little farther round, the visitors were brought to a stand opposite the existing purifier-house, the area of which seemed to strike some of them as stupendous. There are 24 boxes, each 26 ft. by 24 ft. Lime only is used; and the plant in the winter has had to deal with as much as 9¼ million cubic feet of gas. Passing by the condensing and scrubbing plant, the visitors made their way into the new retort-house. Before the present extensions began, there were 832 retorts at the Dawsholm works. In the new house which has been erected, there are 512—raising the number to 1344. The retort-bench is in four sections; the last being in course of erection. One side of the building is merely a wooden screen; the intention being to put up another house in all respects similar to the one just finished, whenever the growing consumption requires it. Leaving the new house, the company crossed over to the old one. Here they were joined by Mr. Foulis, just as they were about to examine his patent drawing-machine at work. The machine was acknowledged by all to do its work expeditiously, and as well as done by hand. The charging at Dawsholm was being performed by manual labour. Leaving the retort-houses, the company walked through the tunnel into the Temple Farm works, and reached the gasholder they had come to see. To the eye, the most conspicuous object was the guide-framing, the lattice-work standards of which, standing 138 feet high, were all but completed. The contractors for the ironwork of the holder were the Barrowfield Iron Company; but they sublet the erection of the standards to Sir W. Arrol's firm, who were able to bring to it men accustomed, from their experience upon the Forth Bridge, to work at a great height. Before leaving the ground, the visitors were, through Mr. Foulis's forethought, shown the method of raising one of the top girders into position. The holder itself is a three-lift one. Two of the lifts and the crown were practically completed; and the workmen were engaged upon the inner lift and the curb. Many of the visitors descended into the tank to its lowest depth—46 feet below the surface—intent upon examining the lutes. To their inquiries as to the dimensions of the tank and holder, the reply was given that the tank (the excavation of which was performed by Mr. R. M'Alpine, of Glasgow) was 240 feet in diameter and 46 feet deep; that the outer lift of the holder was 236 feet in diameter and 45 feet deep; the

middle lift, 233 feet in diameter and 45 feet deep; and the inner lift, 230 feet in diameter and 46 feet deep; and that the crown was untrussed, and rose to more than 20 feet above the curb. General admiration was expressed at the proportions, as well as the workmanship, of the holder. As showing the expeditious way in which the work has been done, it may be mentioned that the excavation of the tank occupied less than ten months; that 9000 cubic yards of puddle, 2000 cubic yards of concrete, and some 4,000,000 bricks were used; that the holder, which is of steel, will weigh 870 tons, and the framing 1200 tons; and that the Barrowfield Iron Company only set to work upon it in September, 1892. After inspecting the works, the visitors were entertained by the Company.

Before leaving, Mr. M'Gilchrist asked the company to accord to Mr. Foulis their hearty thanks for his very kind invitation to them to inspect the works, and to the Barrowfield Iron Company for the trouble they had taken in connection with the visit. Mr. Foulis and Mr. R. Laidlaw (Managing-Director of the Barrowfield Iron Company) briefly acknowledged the compliments.

This brought the first part of the programme to a close; and the visitors returned to the Victoria Hotel, where the business was transacted.

The Meeting.

Mr. Wilson took the chair, and at once proceeded, without any formality, to say he thought the first matter they had to take in hand was the loss the gas industry had sustained through the deaths of Mr. Laurence Hislop, of Uddingston, and Mr. William Mackenzie, of Dunfermline. He thought those present ought to pass a vote of condolence and sympathy with the widows of these gentlemen, and to transmit the minute to them.

The suggestion was agreed to in silence.

The Chairman then said he had to thank his colleagues for having elected him to preside over the meeting. He did not expect such an honour when he came among them last year to make the acquaintance of a few of them. He was glad to say that they met under brighter auspices. Coal could again be bought at a price which, from their point of view, was more like a fair one; coke, although affected by the lower prices of coal, was in good demand; tar and ammoniacal liquor seemed to have touched the lowest point, and were now showing an upward tendency; and workmen had got over, at least for the

present, a period of unsettledness, and were now more reasonable to deal with—the result being that the work went on smoothly, and was consequently better and more cheaply done. Altogether, he thought they might say that the prospects of the gas industry were improving. Their younger helpmate, the electric light, was still being pushed forward; and it would no doubt gradually find its own particular customers. But he did not anticipate that the gas industry would suffer much from its costly rival. This feeling seemed to be shared by the gentlemen who had the direction of the gas business in that city; for, although they had a large installation of the electric light, they were still extending the gas-works in all directions. The holder which, by the kind invitation of Mr. Foulis, they had had the opportunity of seeing that day was expected to be ready in July. In addition to this, they were putting down at Dawsholm apparatus for making an additional 5 million cubic feet of gas per day; and the buildings were so arranged that this quantity could be increased to 10 millions. The new retort-house was to be worked, as far as possible, by machinery. This meant a larger capital account; but, in these days of high wages and short hours, the saving in wages would be so substantial as to more than repay the outlay. In regard to the question raised last year as to whether or not gas took up water from wet meters, anyone could satisfy himself that it was merely a matter of temperature. Gas carried a certain quantity of aqueous vapour, corresponding to the temperature. If that of the meter was the same as that of the incoming gas, the latter would pass on without taking up any water; but if it was above, the gas would take up a certain quantity of water corresponding to the temperature, which would again be thrown down if that of the gas was lowered. The moral was to have wet meters fixed in a cool place. Purification was a subject which caused more anxiety to gas managers in the South than to them in the North. Still, managers in the North had their own special troubles with regard thereto. This was, in many cases, owing to the small area of the purifiers, which caused the gas to pass through the lime at too great a velocity to allow the work to be well done. A little outlay on extra purifying plant was, in such cases, money well spent. The question of coal testing was to the front; and it was an exceedingly important one, as it affected the reputation of gas managers. It pressed most heavily on those who had not apparatus at hand for making working tests of coal. The directors or the gas committee generally believed what

was stated in the analysis as supplied by the coalmaster, which was usually of a coal taken from a picked sample, and consequently gave an ideal value. When these analyses were compared with the actual working results, the directors or the committee were very much surprised to find that their manager had not been able to attain that ideal, but only something like three-fourths of the value of the coal; and consequently he generally had things made rather unpleasant for him. In larger works, little attention was paid to analysis sheets. The tests were made under the actual working conditions; and they expected the results to agree fairly well with the actual value of the coal, as shown in every-day working. Perhaps the Committee of the North British Association, who had the matter in hand, would be able to suggest some method by which the working values of different coals might be obtained. If they had a standard photometer with a standard light in place of candles, it should not be so difficult to arrange to give coal some kind of a standard value such as might be expected to be realized in working. If this could be done in the same way that they had barometers, &c., tested at Kew, it would be much more satisfactory, both for the buyer and the seller of coal. The enrichment of coal gas by means of oil in place of shale or high-priced cannels was steadily gaining ground. In addition to the carburetting of the gas as it was being sent out from the holders, and the use of carburetted water gas, the Peebles system of gasifying oil for enriching purposes had of late been a great deal in evidence; so much so, indeed, that everyone who wished to be "up to date" in the use of oil had to make a pilgrimage to Peebles to see the process in use there. Without going into figures, he might say that the apparatus and the method of working it seemed to be simplicity itself. Whether it was the most economical one, seeing that a large proportion of the oil was vaporized and condensed several times; whether it was as suitable for foreign as for Scotch oils, because, unless this were the case, Scotch oil would soon rise to a fancy price; or whether the system was the best for use on a large scale—these were some of the questions that could only be settled by experience, and by a rather wider trial of the process. Having been accustomed for many years to 16-candle gas in the South, there did not seem to him to be great necessity for anything higher than 18 or 20 candle gas—in fact, he doubted very much if advantage was taken of the extra quality above this. If the enrichment could be done cheaply, or even if the extra candle power could be obtained at anything like

proportionate cost, it might, in some cases, be better to reduce the illuminating power to that which could be produced by using soft coal and low-class cannels. In conclusion, he expressed the hope that the discussion might be as full as time would permit.

Mr. J. M'CRAE (Dundee) moved a hearty vote of thanks to the Chairman.

Mr. A. MACPHERSON (Kirkcaldy) seconded the motion. He said Mr. Wilson had touched upon a considerable number of points in a remarkably short time, and each one was certainly highly interesting to them. He had told them that there was an installation of the electric light in Glasgow; but it was quite evident, from the great extensions they had seen that day, that the Glasgow Gas Trust were not yet quite prepared to be wiped out by the new light. As Mr. Wilson had said with regard to oil gas, it was a question whether the public of Scotland would be pleased to accept a lower quality. It seemed to him that all those who had been acquainted with 16 or 18 candle gas in the South favoured it. It might be prejudice; but he must say that they all had a preference for the higher power. Mr. Wilson doubted whether the advantage of the higher quality was obtained in burning. He thought this was a fallacy, and that it was only a question of burners. He had not yet had the privilege of visiting Peebles to examine the process which Mr. Young and Mr. Bell had produced there; but, from all the accounts he had heard, it appeared to be very successful, although, as Mr. Wilson had said, it seemed strange that it should be necessary to return the oil two or three times into the retort before gasifying it. They might eventually be able to overcome this. But, at any rate, it was a great step in advance; and he was sure they would all welcome it as a very great boon. The remarks Mr. Wilson had made with regard to water in the meters he thought stood to reason.

Mr. J. M'GILCHRIST (Dumbarton) thought the subject of the address might be divided into four heads. The first was capital charges—the great advantage that was to be derived by having the most improved plant. A great many directors, and even committees of corporations, were averse to the spending of money in capital; and he thought that was one of the greatest errors which could be, in connection with gas undertakings. Unless they had proper tools, they could not do their work efficiently. The next point was coal analysis. They knew that this had been a grievous question among gas managers.

for many years past. It was a matter that ought to be settled soon; and he was very glad to convey to them (perhaps it was a secret, but it would soon be made known) that the Committee of the North British Association that day formed themselves into a Research Committee, to go into the question of coal analysis, and to try to lay down a standard means of analyzing coal—a standard that would be acceptable to gas managers, and one that, he had no doubt, would be adopted by coal merchants, seeing that they would be put on the same footing. With regard to oil gas, he was glad they had with them Mr. Alex. Bell, of Peebles, who had given a great deal of attention to it. It was a question that deserved to be well considered by gas managers. He did not care whether he made gas from coal, or oil, or wood. He could hail any substitute for coal, if it were to raise the illuminating power without increasing the cost. Two years ago, when the price of coal was so high, this patent would have been a boon. The only thing he felt inclined to differ from Mr. Wilson upon was with regard to the illuminating power. He had all along held that it was light that people wanted, and not gas; and if they could produce a 25-candle gas cheaper than they could a 20-candle gas, he said it would be a fallacy to imitate the English people by having a lower quality. He thought it was begging the question altogether when people told them they could not get the proper illuminating power from 25-candle gas. Why, they could not get the proper value from 20-candle gas, without they used the means. Unless it could be shown that they could have a unit of light cheaper from 20-candle gas than from 25-candle gas, he would hold by the 25 candles; and he thought this oil gas was probably a means of continuing the high quality that had always been associated with Scotch gas-works. He might say he was sorry when he heard Professor Lewes, in his great lecture on Murdoch,* recommend the people of England to reduce their low illuminating gas. That was, he thought, a sad reflection, not only upon the science of the age, but also upon the people engaged in the industry. The cry was "more light;" and if Professor Lewes could have shown them how to improve the light, rather than to reduce it, he thought he would have been more in the spirit of Murdoch.

Mr. A. BELL (Peebles) said he had much pleasure in rising to make a few remarks upon the oil-gas process, as worked at Peebles. These must, however, be short, so as not to anticipate

* See *Journal of Gas Lighting*, Vol. LIX., p. 1177.

what might be done at a future meeting. As every gas manager was aware, the increasing scarcity of cannel coal had made it necessary that a substitute should be found for it. There was an inexhaustible supply of paraffin and petroleum oils; and the attention of those connected with them had been directed to that source, with the result that several processes were in existence for the manufacture of gas from oil. But they had this drawback, that they were adaptable only to oils of low specific gravity. It was at once evident that, before oils could be economically applicable to gas making, the system must be capable of dealing with heavy oils. It was with the aim in view of finding such a process that Mr. Young instituted his experiments at Peebles; and the results had been entirely satisfactory. The Peebles plant, after an experience of six months, had, he was confident, overcome the difficulty. The process was so complete that it could deal with oils as heavy as coal tar, and convert them into gas and coke. That was, he thought, a most important point in these days, when they obtained so little for their tar. The plant at Peebles was exceedingly simple, and very much resembled that for coal gas. It consisted of an iron retort; and the gas passed off by an ordinary standpipe, and through a condenser and scrubber to the purifier. The oil was introduced into the iron retort by the standpipe. It was made to pass through the retort several times. The object of that was to reduce the temperature inside the retort, and wash back any sooty matter that might be carried off; so that, after putting through a ton of oil, they had 22,000 cubic feet of gas, which had passed away, and 5½ cwt. of coke left in the retort. The coke they had sold at as high a price as £1 per ton. The process was, in fact, very similar to what had been practised for many years in oil-works, in the cracking up of heavy oils into lighter oils. What they had done was merely to carry the system farther. That was the reason for running the oil back, over and over again—in fact, it was more like a process of simple distillation than destructive distillation. He did not know that he could say much more without describing the plant in its place; but he would be very glad to explain this in practice to as many gentlemen as might find it convenient to go to Peebles.

Mr. MACPHERSON: How long does it take to put a ton of oil through?

Mr. BELL: It depends on the amount of gas you are making. We had two retorts at work in Peebles last winter; and each of these was capable of producing 10,000 cubic feet per day.

Mr. M'CRAE asked how far the gas could be carried; and if there was any difference in the gas supplied from that sent out.

The CHAIRMAN: In other words, is there any loss between the works and the consumers' burners?

Mr. BELL: None whatever. The gas is even more permanent than cannel coal gas. In the six weeks of very frosty weather last winter, it was not nearly so much affected as coal gas.

Mr. M'CRAE: What was the unaccounted-for gas?

Mr. BELL: The unaccounted-for gas in the corresponding quarter of last year was practically the same.

Mr. T. D. HALL (Montrose) said there were one or two points he would like to notice. He was very pleased and gratified to hear a gentleman in the position Mr. Wilson occupied say he was able to hold out brighter prospects for the gas industry. He had seen the electric lighting station in Glasgow, and felt that electric light had come to stay. When he viewed that large gasholder, he could not help thinking that gas would also remain. It would take about 600 tons of coal to fill that large gasholder with gas. Mr. Wilson had made some remarks about the presence of water in gas. This was brought forward last year; and from another year's experience, he could only repeat that all the water that was found in internal gas-fittings came directly from the meter. He had watched it very closely during the twelve months; and he must say that he had not had a single case of water, or jumping lights, in a house where the gas was measured by a dry meter. The testing of coal was an extremely difficult matter to deal with; and he did not really know whether or not a Research Committee would be able to arrive at any cure for that sad business. He was almost inclined to think that they would each have to depend upon his own resources to find out what was wanted. He had an idea that, if they could get the managers of large works, who had apparatus at their disposal for practical testing, to issue lists of well-known coals for the benefit of the gas industry in general, that would be one way of arriving at a standard; and they could discard all laboratory work whatever. Illuminating power was also a very important question. Having had a pretty large experience of manufacturing and consuming gas of low illuminating power, he was inclined to lean that way; but he would not put it so low as some did. He would put it at from 18 to 20 candles.

Mr. A. YUILL (Alloa) stated that he had agreed to introduce the Peebles process of oil-gas making; and he might mention that he had given the question a great deal of consideration.

He went to Peebles on several occasions, and investigated the matter; and he prepared reports for his employers. There were one or two points brought out which were rather curious, and which, in his opinion, dispelled the idea of low illuminating gas. One gentleman had mentioned the cost per unit of light; that was brought out. The cost for oil and coal, using 8 per cent. of oil, amounted to 2·13d. per 1000 candles for 30·37-candle gas. If they took 24·13-candle gas, using less oil, of course, the cost per 1000 candles was 2·36d.; showing that they paid more per 1000 candles for the lower than for the higher quality gas. The cost of 24·22-candle gas from coal and shale was 2·54d. per 1000 candles, against 2·13d. for 30·37-candle gas from coal and oil. The higher the illuminating power they obtained from coal and shale, the more the cost rose. Did not these figures prove conclusively that the lower illuminating power gas from coal and oil cost more than the higher? If they took the sperm value obtained for a penny, they found, in the case of coal and oil, that of 30·37-candle gas they had 8·03; if they took 24·22-candle gas from coal and shale, they got 6·65—again showing that it cost less to give the higher illuminating power gas. Therefore, he held that it was more economical to make the higher illuminating gas. The cost of production also stood in the same ratio. To manufacture 30·37-candle gas from coal and oil cost 9·98d. per 1000 cubic feet; and to make 24·22-candle gas from coal and shale, 9·98d.—just the same. These figures were based on prospective reductions in price; and the cost of coal and oil was on the cost of coal at the present time and the latest quotations for oil.

Mr. MacPherson said he was favoured the other day with a circular from a Mr. Laing, who was also, he believed, working out an oil process. From the rough sketch he sent, it seemed that he put the oil into a boiler. From that boiler he led the vaporized oil away by a neck perhaps 2 feet in diameter, which he filled with scrap iron; and the furnace gases, after vaporizing the oil in the boiler, also superheated this neck. The gas then passed on to the scrubbers and condensers in the usual way. He did not know if the system had ever been tried in practical form; and he simply mentioned it, in case any gentleman there was not aware that such a process was being brought out.

Mr. P. B. Watson (Falkirk) asked how much it would cost to enrich to 26 candles.

Mr. Yuill replied that 1 per cent. of oil raised the illuminating power one candle. If they wanted to raise 18-candle gas to 25 or 26 candles, it would take about 8 per cent. of oil.

Mr. M'CRAE inquired if Mr. Yuill would say that to raise 15-candle gas to 16½ candles would take the same percentage of oil as to raise it from 27 to 28 candles.

Mr. YUILL said his paper (which he had handed to the Chairman) would show that.

Mr. MACPHERSON thought Mr. M'Crae's question was being misapprehended.

Mr. M'GILCHRIST said he expected Mr. Yuill gave the 1 per cent. as an approximate figure.

Mr. YUILL did not say it would be found in every case.

Mr. M'CRAE said that, if they took Scotch splint, they would get 15½ candles; but if they used Scotch cannel, yielding 26 to 27 candles, would they then get one candle for 1 per cent.?

Mr. YUILL did not think those present would for a moment think of taking to oil if they were using rich cannels.

Mr. M'CRAE: I am merely asking a question.

Mr. YUILL: I am not prepared to answer it.

Mr. MACPHERSON: I think that is inconsistent of Mr. Yuill, because his quotations have been all up among the 30's.

The CHAIRMAN thought they might let the matter rest till the North British Association meeting, when, he understood, Mr. Bell was to give them a paper on it.

Mr. WATSON repeated his question.

Mr. BELL replied that they had been raising the candle power of splint coal gas up to 30 candles all the winter; and it had been costing them, for coal and oil, 14½d. per 1000 cubic feet, which was from 8d. to 10d. less than could be done with cannel coal and shale.

A question was asked, whether there would not be an excess of the vitiation of the atmosphere by the combustion of oil gas, seeing there were the carbon compounds in oil gas.

Mr. BELL said there was no difficulty in burning the gas, if they had a proper burner. They had a few complaints in Peebles until the burners were changed; but they had none now.

The CHAIRMAN, in closing the discussion, replied to one or two of the observations which had been made. Dealing with the subject of oil gas, he said there could be no doubt that, as they went higher for extra candle power, the oil must cost more.

Mr. YUILL begged to be excused; the very opposite was the case. The higher they went with coal and oil gas, the cheaper it was per unit of light. If they took coal and shale, it was just the reverse.

The CHAIRMAN said that what he wanted to impress upon the meeting was that it could not cost so much to raise gas from

16 to 22 candles as to raise it from 16 to 28 candles. To raise gas from 15 to 16 candles could not cost so much as to raise it from 27 to 28 candles, because there was actually more sperm value in the latter.

Mr. YUILL referred to his paper to show that the more they went down in illuminating power with coal and oil, the higher the cost was.

The CHAIRMAN said this did not seem to him to be feasible.

Mr. BELL substantiated what Mr. Yuill had said, that the richer the oil and coal gas was made, the cheaper it was to the consumer. It was a little higher to the maker; and the reason was that the cost of oil gas per 1000 candles was actually cheaper than the cost of splint coal gas per 1000 candles, and by increasing the illuminating power they were actually raising the cheaper oil gas to the dearer coal gas.

The CHAIRMAN understood it to be this: The oil gas was so cheap that the higher the illuminating power it was so much in favour of the total gas; but, all the same, it seemed to him that the sperm value of one-candle power—say from 26 to 27, instead of from 15 to 16—must be very much higher.

Mr. YUILL pointed out that the figures he quoted were based on the practical working at Peebles—they were not his.

The CHAIRMAN said there was a little misunderstanding; but it would be cleared up at the North British meeting.

Mr. M'GILCHRIST then proposed that Mr. Thomas Wilson, of Coatbridge, be appointed Chairman for next year.

Mr. M'CRAE seconded the motion; and it was agreed to.

The CHAIRMAN having acknowledged a vote of thanks which had been accorded to him, the proceedings terminated.

Dinner was afterwards served in the hotel.

VISIT TO THE TRADESTON GAS-WORKS.

Some of those attending the meeting visited the Tradeston Gas-Works in the evening, or on the following morning. The station has been almost entirely rebuilt since it came into the hands of the Glasgow Corporation. The retort-house contains 816 retorts, set in three double benches. The firing is on the Siemens system. It is, however, in the arrangements for mechanical stoking that the chief merit of the place is to be found. This is done—both charging and drawing—by machines which have been devised by Mr. W. Foulis and Sir W. Arrol—the charging-machine by the two gentlemen in combination, and

the drawing-machine by Mr. Foulis alone.* The coal-store is at the end of the retort-benches. An elevated railway, running at right angles to the benches, brings the coal into the works. It is sent down a shoot into the coal-breaker, which is situated on the ground level; and it is driven by a steam-engine, situated in the basement floor. The same engine works an elevator, by which the broken coal is carried to nearly the roof of the house, and deposited in a large storeage-box, with hopper arrangement, capable of holding 20 tons. There is on the charging-machine a fixed hopper, made to contain 5 tons, which is equal to serving 40 retorts. Having been loaded from the box, the machine is brought in front of the setting to be charged. At intervals along the house, there are flexible hose hanging from the rafters, which convey the hydraulic power by which the machine is worked. One of these is attached by a simple catch to the machine; and the man in charge, by the use of a couple of levers, has then full control over its movements, in so far as they are not automatic. The charging is accomplished by a series of thrusts. A long arm with a plate attached, like the head of a rake, is sent into the retort to within 9 inches of the back. On being withdrawn at the end of the stroke, it works a lever, which operates upon a drum in the bottom of the hopper, and releases a certain quantity of coal, which falls into position. The next thrust of the arm sends this coal to the back of the retort. On being again withdrawn, the same quantity of coal is released; but the arm this time, by means of an automatic arrangement, when it is again thrust in, stops short of the length of its former journey by a specified number of inches. On each succeeding journey, it does the same, until, on the last occasion, it stops just inside the mouth. Six thrusts are sufficient to charge a retort. Each oven contains eight mouthpieces; and the time required to serve the whole is six minutes. The coal is laid just as evenly as by hand. The drawing-machine works similarly. It has, however, an arrangement whereby the waste water from the hydraulic appliances is made to spray upon the rod of the rake, thereby keeping it cool; and after serving this purpose, it falls upon the coke which has been drawn, and extinguishes it. The operation of drawing eight retorts occupies six minutes. By a peculiarly-shaped hopper arrangement, the coke, as it falls from the mouthpiece, is conveyed by shoots to the basement floor, where it is deposited in

* These machines, in their original form, were described in the *Journal of Gas Lighting* for Sept. 27, 1892 (p. 555); but considerable improvements have since been made in certain parts.

shallow trucks; and these are then drawn out upon an underground railway to the coke heap, by a diminutive locomotive engine, in all respects like an ordinary railway locomotive, but so tiny that the top of the funnel is not more than 5 feet from the ground. The gauge is a 2-feet one. By this arrangement, the floor is kept clear of barrows and trucks; and the way is left quite free for the passage of the charging and drawing machines. When it is required to charge a producer, another form of hopper is placed in front of the oven, which collects the falling coke, and directs it to the charging-door. A significant feature of the retort-house is the absence of the crowds of workmen who used to be employed, and whose places are now taken, and whose work is done, by machinery much more silently and expeditiously than they were ever able to perform it. For supplying the hydraulic power, a steam-engine is stationed in an out-of-the-way corner of the basement floor. It works quite automatically—starting, stopping, and regulating its speed to suit the work which may be required of it at the time, no one going near it, except to oil it. The purifier-house is capable of passing 6 million cubic feet of gas per day. In it, there is an ingenious and handy device by Mr. Foulis for the removal of the covers, which is also a feature of the Glasgow Corporation Gas-Works. At each corner of the box is an upright-rod, worked by hydraulic power, by means of which the cover is raised to the required height. The upper edge of the lute is formed into a rail; and when the cover is raised sufficiently, a carriage is placed on the rail at each end, and the cover is lowered on to it. Then a connecting-rail is placed across the passage to the neighbouring box; and the cover is wheeled over upon the top of its neighbour, where it rests until the contents of the box have been dealt with. This arrangement does away with the customary block-and-tackle arrangements, and is found to work better. In all the works, the plant has been laid down with a view to easy extension. A second retort-house can be built alongside the existing one; a double set of exhausters can be placed in the exhauster-house; the purifier-house may be doubled in extent; there is room in the meter-house for an additional station meter; and in the yard there is ample space for another large gasholder.

WAVERLEY ASSOCIATION.*

HALF-YEARLY MEETING, APRIL 13.

This Meeting (the sixty-fourth) was held in the Cross Keys Hotel, Dalkeith—Mr. J. BLACK, of North Berwick, in the chair. In view of the fact that the subject of the use of oil in the manufacture of gas was to be considered, there was a good attendance of members.

The minutes of the preceding meeting, held at Peebles in September, having been read by the Secretary (Mr. George Taylor, of Jedburgh), this gentleman was unanimously chosen President for the ensuing year; Mr. Dunlop Smith, of Hawick, being appointed Treasurer and Secretary.

Mr. A. BELL, jun. (Peebles), then gave an address on the oil-gas experiments carried on by Mr. Young and himself at the Peebles Gas-Works. He explained at the outset that his object that day was not so much to make a speech as to give some practical remarks on the subject of the manufacture of oil gas. The scarceness of cannel coal had compelled gas managers to look for a substitute. On account of the cheapness of petroleum and paraffin oils, the attention of those interested had naturally been directed thereto, with the result that several different processes were in operation. These had all been more or less successful; but they were subject to one defect—that only oils of low specific gravity could be used. It was evident, before an oil-gas process could be successfully and economically applied, that it must be capable of dealing with crude oils of high specific gravity, as it was these which constituted the greater part of the home and foreign supplies. It was with this object in view, that the experiments at Peebles had been undertaken. After an experience of six months, he could confidently say that the process had entirely overcome,

* The reports of the meetings of this Association, being gatherings for the conversational discussion of gas matters, have not hitherto been included in these volumes of Transactions. An exception has, however, been made in the present case, in view of the interest attaching to the subject considered.

all the difficulties connected with making oil gas. The plant employed was exceedingly simple, and resembled very much an ordinary coal-gas plant. It consisted of cast-iron retorts, stand-pipe, hydraulic main, condenser, and scrubber. Mr. Bell went on to describe the process, by the aid of diagrams; showing plans of the plant being fitted up at Galashiels and Musselburgh. In regard to the illuminating power, he said it was impossible to get at it directly; but by mixing five parts of 18-candle gas with one part of oil gas, the average of 30-candle power was arrived at—the difference between the 30-candle and the 18-candle gas being due to the oil gas, making it equal to 90 candles as an enriching agent. Since the end of November they had used common splint coal at 10s. 4d. per ton; and oil costing 40s. per ton. The following was the report for the month of December:—

Material Used, &c.	Cost.	Cost per 1000 Cub. Feet.	Cost in Dec., 1891
Paraffin oil (·885 sp. gr.), 12 tons 2 cwt., at 40s. per ton. . . .	£24 4 0	—	—
Bellfield splint coal, 75 tons 5 cwt., and Auchlochan, 59 tons 15 cwt. —135 tons at 10s. 4d. per ton .	69 15 0	—	—
Total weight of material, 147 tons 2 cwt.	£93 19 0	14·43d.	20·88d
Lime, 6 tons 12 cwt., at 14s. 9d. .	4 17 4	0·74	0·83
Manager's salary and wages . .	32 11 6	5·00	5·07
Total	£131 7 10	20·17d.	26·78d.

Residuals Produced.	Return.	Return per 1000 Cub. Feet.	Return in Dec., 1891.
Tar and liquor, 9100 gallons, at 2s. 8d. per 100 gallons. . . .	£12 2 8	1·86d.	5·24d.*
Coke from coal, 34 tons 8 cwt., at 8s. 4d. per ton	14 6 8	2·70	1·82
Coke from oil, 3 tons 5 cwt., at 20s. per ton	3 5 0		
Spent lime, 13 tons 4 cwt., at 1s. 6d. per ton	0 19 10	0·15	0·31
Total	£30 14 2	4·71d.	7·37d.
Net cost of gas into holder.	£100 13 8	15·46d.	19·41d.

Working Statement.

Oil gas made	268,100 cub. ft.	= 22,157 cub. ft. per ton.
Coal gas made	1,293,000 ,,	= 9,580 ,, ,,
Total gas made . .	1,561,400 ,,	= 10,614 ,, ,,
Do., Dec., 1891 .	1,908,700 ,,	= 9,780 ,, ,,
Tar and liquor	9,100 gallons	= 67·40 gallons p. ton of coal.
Do., Dec., 1891 .	11,500 ,,	= 59·00 ,, ,, ,,
Coke from coal. . . .	34 tons 8 cwt.	= 5·09 cwt. ,, ,,
Do., Dec., 1891 .	34 ,, 15 ,,	= 3·60 ,, ,, ,,
Coke from oil	3 ,, 5 ,,	= 5·37 ,, per ton of oil.
Gas made since balance .	6,502,600 cub. ft.	
Do. for Dec., 1891	7,075,500 ,,	

* The price of tar and liquor was only 2s. 8d. per 100 gallons in 1892, as compared with 7s. 3d. in 1891; being equal to a loss of 3·38d. per 1000 cubic feet of gas.

Dealing afterwards with the cost of plant, Mr. Bell stated that the erection at Peebles cost £140; and it was capable of producing 20,000 cubic feet of oil gas per day—making the cost equal to £7 per 1000 cubic feet of oil gas. In calculating the cost of plant for different works, it was safe to reckon from £7 to £10 per 1000 cubic feet of oil gas required per day.

In the course of the discussion which followed, most of the members expressed satisfaction with the result of the Peebles experiments.

Mr. A. Bell (Dalkeith) said that he had naturally watched all along with very great interest the experiments being carried on by his son at the Peebles Gas-Works. With regard to the price of coal, it must undoubtedly come down. At the same time, oil was rising in price. Were the larger gas undertakings, like those in Edinburgh and Glasgow, to introduce it, the demand would be far greater than the supply of the country; but he would remind the members that the quantity in Russia and America was unlimited. Even at £3 per ton, it would pay them to import it. Supposing they took oil at £4 per ton, it would be nearly as good an enricher as the Marquis of Lothian's cannel coal at 18s. per ton. He expected that before very long the Directors of the Dalkeith Gas Company would begin the manufacture of oil gas. With oil gas they had the power of enrichment at a very low rate, and could compete with the electric light on more equal terms; so that, if people demanded gas of high illuminating power, it could be supplied at much cheaper rates than with first-class cannel coals, which were becoming scarcer and naturally higher in price.

Mr. W. Blair (Haddington) said he thought that gas managers, even though they might not adopt the process, were greatly indebted to the Peebles gentlemen, as they had been able by their experiments to cause the price of coal to fall; and they knew that cannel had gone beyond limits during the last few years.

Mr. R. M. Sutherland (Falkirk) remarked that, although scientific progress threatened to some extent to extinguish his particular occupation, he should not like to arrest it. They would all be pleased to hear the oil-gas process was a pronounced success. He thought, however, there was a little misapprehension in regard to the oil that was being used with it. It was what was called "blue oil," of ·884 specific gravity. This was a lubricating oil, which formed about 20 per cent. of the crude oil. The total production of crude shale oil in Scotland

amounted to 50 million gallons, or about 200,000 tons. If they were to confine themselves to the class of oil of ·884 specific gravity, they would only have something like 40,000 tons per annum. There was no doubt they could look to America, Russia, and other places, for an unlimited supply of petroleum or natural oil. The use of this particular oil would have a tendency to increase the quantity of shale oil in this country, and would make paraffin or burning oil more abundant. One of the difficulties of using crude shale oil was the presence of wax or paraffin, which necessitated the oil being kept at a temperature of 90° Fahr. Still, this was only a practical difficulty, and one that could be overcome. In using crude shale oil, they had the wax, which was one of the most valuable of constituents for the manufacture of illuminating gas. The more varieties of oil experimented upon for manufacturing gas, the more would the field be widened, and the success of the process ensured.

A MEMBER remarked that Mr. Ivison Macadam had recently stated that 26-candle gas would give better results, with the burners at present in use, as it was more economical than gas of higher qualities.

Mr. BELL replied that he believed they had been supplying gas of too rich a quality; but he would not now be inclined to go so low as Mr. Macadam had recommended.

Votes of thanks closed the discussion; and the members afterwards dined together.

NORTH OF ENGLAND ASSOCIATION

HALF-YEARLY MEETING, APRIL 29.

This Meeting was held in the Offices of the Newcastle and Gateshead Gas Company—Mr. J. Whyte, Manager of the Seaham Harbour Gas Company (the President) in the chair.

The Proposed Federation of Gas Associations.

The President read a letter received from the Honorary Secretary of the South-West of England District Association of Gas Managers (Mr. Norton H. Humphrys), submitting two resolutions on the above subject passed at the meeting of that Association on the 11th of April and requesting that the matter might be brought before the North of England Association at the earliest opportunity.

The Secretary (Mr. W. Hardie, of Newcastle) having read the resolutions, which will be found on p. 70,

Mr. T. Bower (West Hartlepool) proposed that the letter and resolutions be referred to the Committee, with power to answer the former in the manner they thought most expedient.

The motion was agreed to.

Introductory Remarks by the President.

The President, addressing the members, said: In opening this meeting for the disposal of the business before us, I must express my pleasure at seeing such a company as we have here to-day. During the past year we have again been reminded of the changefulness of all earthly associations; our ranks having been broken by the rude hand of Death. I refer to the loss of our fellow-member Mr. Burns, of Sunderland, who retired only a few months ago, by reason of his declining years, to enjoy, as we all hoped, the well-earned rest and reward of long faithful service; but it was otherwise ordered. Though it is not usual to give an address from the chair at our annual meeting—a custom from which I will certainly not depart—I may be expected to say something in regard to our present and future outlook. As for the present, we certainly have a clearer atmosphere than we have had for the past year or two.

Coal, which has so long been at famine prices, has now reached a figure which I think can hardly be regarded as unreasonable, when we come to consider the various items that go to make up its cost. As a proof of the change in prices, I may mention that a colliery manager informed me some weeks ago that a contract his company had for 40,000 tons of coal had just expired, and they were asked to renew it at exactly one-half the rate, or 5s. 9d. per ton—a proposition which, I may say, was declined with thanks. Tar, which about twenty-five years ago, (according to Mr. Perkin) was said to contain some fifty different substances, may to-day be put down as having nearly four times fifty; and still fresh discoveries are being made. Yet the price of tar continues very low indeed. I venture to predict that it will be utilized to greater advantage in the future than it has yet been. Let us hope that the present slight improvement in value is only as the "early drops of the coming rain." Sulphate of ammonia has certainly risen very considerably in price of late; and I am sure I only echo your sentiments when I express the hope that it may long continue, so that both gas and chemical companies may recoup themselves for the long period of depression they have passed through. The labour market, so far as gas-works are concerned, is comparatively quiet; but when we look around generally, it almost seems that this is the painful stillness that precedes the dreadful storm. During the past year, a great advance has been made in the manufacture of gas. The *modus operandi* adopted in the Peebles works for gasifying oil (and tar also, if I am not mistaken) has passed the experimental stage, is now an accomplished fact, and only wants time for development. The other process—and one with which we are deeply concerned—is the Yeadon, which I will not attempt to describe, as we are to have a paper upon it from our friend Mr. Terrace, in whose practical hands it is quite safe. I will not therefore try to forecast the result of his experiments. I thank you for your kindness in bearing with my shortcomings since you elected me to this honourable position, and still crave your help to make our present meeting both pleasant and profitable.

Mr. DAVID TERRACE (Middlesbrough) then read the following paper :—

THE YEADON ROTARY SYSTEM OF GAS MAKING.

Notwithstanding the many inventions intended to alleviate the lot of the gas stoker, and at the same time be made to pay their way in the working of our raw material—coal—there does not

appear to be any one that may be said to be of universal, or even general, application. In several large works, stoking machinery has been introduced; but there are many similar works where one would suppose the conditions were equally favourable, but the managers of which appear to be holding back, I opine, till the perfect machine is invented, or, it may be, to note the fate of the later developments—inclined retorts, or other systems. I am of opinion that it depends greatly upon the treatment the various stoking devices receive at the hands of those working them, whether they turn out a success or otherwise; and, if so, one need not be surprised at the apparent hesitancy we note all round. What we should first of all determine is: Is the principle of the machine or other appliance sound? If satisfied on this point, then I should say adopt it, and make certain that it is fairly worked out in its every detail. Steam or other power is bound in time to take the place of arduous hand labour; and I venture to assert that we would all hail the advent of any machine or system that would meet our requirements.

To-day we are to consider the latest invention in the direction of automatic carbonization—viz., the Yeadon revolving retort, in which we have some novel features presented.* The retort, about 7 feet of which is exposed to the fire, is conical in form, and is made of cast iron; revolving, on a horizontal axis, about three turns per minute. The diameter of the heated part is about 2 ft. 6 in. at the feeding end, and 3 ft. 6 in. at the discharging end. Cast solid with the retort are four feathers, which, in revolving, constantly keep the coals stirred. An external ring rib is cast on, to strengthen the body of the retort which is exposed to heat. There are stuffing-boxes with asbestos packing in the stationary part at either end. Means are also taken to prevent in-draught of air into the furnace, by having segmental strips of iron close to the revolving retort. Plain rollers, revolving in water-trough castings, support the retort at the feeding end; while at the discharging end the rollers are V-shape, to keep the retort in its position longitudinally—the expansion caused by the heating taking place at the feeding end, where provision is also made in the driving-pinion being more than double the width of the wheel attached to the retort. The stuffing-box at the feeding end is also elongated, to allow of expansion; and jets of water play on the packing, for cooling and lubrication. At the feeding end is a hopper, kept constantly full of the coal, which in turn is forced into the

* This retort has been described and illustrated in the *Journal of Gas Lighting*. See Vol. LV., p. 787, and Vol. LX., p. 1042.

smaller end of the retort by blades fixed spirally on the shaft. The coal drops from the end of the pipe into the retort, which, being conical and revolving (with internal feathers), is made to travel automatically to the larger end, where the cinder falls into a recess, from which it is discharged by similar spiral blades. The coal can be automatically fed by conveyors into the hopper; and the cinder may be taken away by similar conveyors. A small engine (about 1-horse power) drives a shaft on which are a pair of bevel wheels, which communicate motion to a longitudinal shaft parallel to the retort. On this shaft are two pinions gearing into large wheels—one fixed near either end of the retort. On the first motion is a pulley on a countershaft, with a cone driving another with a worm and wheel on the shaft, with spiral blades feeding the coal into the retort. At the larger end, the longitudinal shaft, by means of bevel gearing, drives the discharging blades. The elevators and conveyors can also be driven from the same range of shafting. There may be one or more retorts set in a bed, and heated by an ordinary furnace or by regenerative firing, as may be found most convenient. The gas produced is taken off at the larger end of the retort by the usual exhauster arrangements; the vacuum inside the retort being regulated, so as to prevent the possible escape of gas or in-draught of air. The closely-packed coal at the charging end, and the similar tightness of the cinder, keeps the retort practically closed, if there be not too great variation caused in the range of vacuum by the exhauster.

One of the chief merits of this system is that the coal, being constantly kept in motion by the revolving action of the retort, is made to give up its gases in a very short time (some twelve minutes being sufficient), instead of, as at present, extracting the gas, &c., by first spreading the coal in layers, and subjecting the inert masses to heat for six hours. Another advantage of keeping the coal in motion is that this form of retort is particularly adapted for carbonizing the very smallest, and consequently the cheapest coals, which many works reject at present as being unsuitable for the purpose of gas making with the ordinary retorts. It also appears that, in the Yeadon retort, not only is the gas, in the ordinary sense, obtained, but the tarry and other matters, which we find in our liquor-wells, are also converted into useful gas, and this of a higher illuminating value. As an evidence of this, it may be stated that, from experiments which have been made, some 2000 cubic feet of gas per ton more in quantity, with increased candle power have been evolved.

By thus volatilizing at one process all the available illuminants, you will be prepared to learn that the remaining tar, &c., is of decreased value. But not only is this the case with the liquid matters, but the solid residue, or cinder, is also useless as coke. (It appears, however, that other uses are being found for it.) So that there is a *total* destructive distillation of the coal in this mode of carbonizing. We have thus a new set of commercial conditions set up.

It will very naturally be asked: "What relationship is there between the gain in sperm value and the loss from the non-production of coke, and the values usually obtained in present working? We should, however, first take notice of the question of labour, which is practically all, or nearly all, accomplished by the machinery, the mere attendance upon which may be said to be all that is necessary—the hard manual labour being dispensed with, except for keeping up the heats, and for this it is proposed that gaseous firing would be introduced. On the other hand, there is the first cost of the machinery, and also the wear and tear, to be taken into account. But when it is considered that a revolving retort is capable of producing five to seven times the quantity of gas from a greatly less consumption of fuel in the furnace, and that it occupies less ground-space, it will be conceded that there may be even less expense under this head than at present.

As the retort has only been working experimentally, at frequent intervals, during the past two years and a half, and as it is not now so capable, on this account, of being worked to the same advantage, we do not have exact working data; but the following may perhaps be taken as a sufficiently near estimate of the difference of cost per ton, comparing the present working with the revolving retort:—

			Per Ton.
Gain.—In using the smaller kinds of gas-producing coal			1 6d.
In labour—			
Carbonizing at present costs	3s. 0d.		
Say, for revolving retort	1 0		
			2 0
2000 cubic feet of gas (say) at 2s.			4 0
Increased candle power			0 6
Total gain			8 0
Loss.—Coke (say) 8½ cwt. at 6d.	4s. 3d.		
Difference of tar, &c., values	0 9		
			5 0
Balance in favour of revolving retort			3 0

The foregoing statement would necessarily vary somewhat in different works, and such allowances could be made on the items mentioned.

As to the other advantages of the retort in question, it may be thought that the want of coke production is in the reverse ratio; but doubtless—if one may judge by recent experiences—it would have been a good riddance to be clear of a large proportion of the coke made by the ordinary means, as thousands of tons have been stocked at great expense, and after all a very low price per ton had to be taken for it. Tar and liquor, too, have been a drug in the market for some years. A restriction in their production might have a beneficial effect on our getting something like the intrinsic value—if such a term can be applied in that sense—instead of only about one-third of it, as is at present often the case.

Generally, the result of the adoption of such a retort as described, would be that about half the quantity of gas (say) during the winter season could be made on this principle. This might involve that another class of labour for carbonizing would be employed in the busy season—leaving the regular hands practically undisturbed all the year round, or *vice versâ*. Supposing a good stock of coke were remaining in the spring, the revolving retorts may be kept going, or otherwise, as the circumstances of labour, &c., may determine. In a word, it would put us in possession of the proverbial "two strings" to our "bow;" and, in our particuiar case, this other string has long been a "felt want" in these later days.

There is yet another phase in which we ought to look favourably on this invention. I refer to its applicability for re-burning spent gas lime. A retort that could at pleasure be made to either manufacture great quantities of gas, or turn to a useful purpose that which is so much waste, would be a very great boon in many works. It is well known that lime can be re-burned; and it has only been for want of the means whereby this could be readily accomplished, which has deprived many managers from devoting special plant to the purpose. The revolving retort would thus be a very economic appliance; and we await with confident expectation its being fully adapted and further tested in our interests. Its future development will be eagerly looked forward to; and machines should now be put in practical operation at various gas-works, where all the details of working—both for coal and spent lime—would be carefully noted, to guide those who may apply the system as a permanent installation.

Discussion.

Mr. W. FORD (Stockton) said Mr. Terrace's paper had been short, and to the purpose; but one's mind could see a considerable number of objections upon which Mr. Terrace had not touched. He must confess that, when he went to see the apparatus, he went with a mind prejudiced against its likelihood of ever being introduced as an element of success in gas manufacture. But, from further experience in the examination of the appliance he had come to believe that there was something in it; and it only remained, in his opinion, to confirm what Mr. Terrace had said in his paper—that there should be a practical application of it in some gas-works, under practical gas management. The experiments which had been made were, no doubt, very good; but an apparatus of this description, when it was put to every-day work, would be either of great advantage to them, or it would be thrown on the scrap-heap, as, in his experience, so many of the inventions that had been brought before them during the last 35 years had been. Some of these had gone to their own account, without having left any result; but in this apparatus he saw a future, provided the practical objections which in his eyes remained could be removed. He might say that, like Mr. Terrace, he had had the advantage of seeing the appliance at work; and one thing which struck him against its introduction was the question whether it could be demonstrated in practice that it could be worked continuously. He must hesitate in believing that this had yet been demonstrated. The fact of its being worked at intervals was in favour of the process; but it had yet to be shown that it was capable of running for seven days a week, granting even that a small space of time were allowed each day to recoup, because they must understand that the coal was going in continuously, and there was no rest. It was always green coal that was running in; and they all knew what was the effect of putting coal into a retort, with reference to the heat. There was one advantage of this process, and it was that they could "lay it off" on the Saturday night, and come back an hour or two earlier on the Monday morning and start it again. This was a great advantage, because, as all present were aware, the troubles with their men arose with those who came in for three or four months in the winter. The steady old stoker they had all the year round was not inclined to agitate; while the other man only wanted all he could get out of them for the two or three months' work he gave. The machine seemed complicated; but he must say that any gentleman who saw it at work would come

to the same opinion that he did—that it was much simpler than it appeared on paper. Taking it for granted that the coal was to be a gas-producing coal, he was at one with Mr. Terrace in his statement that they might save 1s. 6d. per ton. There was no doubt that the smaller the coal the better this apparatus would work it. There was with it none of that great heat and labour which they had even in stoking-machines. He did not think the heat was quite done away with in these machines. It might be that the inclined retort system would be of much advantage in that way. Of this, he had had no experience; but they hoped to hear before long Mr. Terrace's views on the subject. There was, he thought, not the slightest doubt that the loss of tar would not be to their advantage. He believed that for the tar destructively distilled in this process, they did not have the proper proportion in value either of gas or illuminant. This might be accounted for to some extent by the state of the retort as they found it. It was very old—two years and a half; and they all knew (at least the older members did, who had had experience in the working of iron retorts) that when they once began to give way they were very difficult to patch up. This was a matter that would be easily overcome; and the very fact of this retort having been heated up 50 or 60 times a year showed there must be something in it. With it, they could start to make gas in a few hours. Suppose a London fog came on, what an advantage this apparatus would be to a London Gas Company if they had a hundred or so of them in reserve. Fancy the quantity of gas that could be evolved from the retort in a few hours! It was capable of doing the work of 28 ordinary retorts; and they knew the time it took to light up such a number by the usual process. The fog might come and go again before they were ready for work; but with this apparatus they would have the gas generated and sent into the holder in a few hours' time. There was really no mechanical difficulty that he could see in the process; and all he wished was that it should be adopted in some gas-works, and put to practical work during the coming season.

Mr. T. Bower (West Hartlepool) said he went to Leeds, with Mr. Ford and Mr. Terrace, to see the invention they had heard described. When he saw the apparatus at work, his first impression was that there was something very novel in it, and something, as he thought, which was a decided improvement upon anything hitherto introduced. But, on further investigation, several things occurred to him which it might not be desirable to adopt. He believed, however, it was the intention

of the patentees to make considerable improvements in the apparatus. One point which struck him was that which Mr. Terrace had mentioned, as to the admission of air into the retort. Means were, he believed, to be taken to mitigate this as much as possible. But it seemed to him that, in those openings, they had a source of evil which might be very serious, and which, if not very carefully kept in check, might seriously affect the results. He agreed with Mr. Ford as to the working of the apparatus. One of the greatest advantages of the retort was its being capable of being started at very short notice, for temporary purposes such as fog. When he reached home, he carefully thought over the matter, and began to work out some results, and to compare them with those which he was getting by the ordinary process; and he was free to confess that he underwent a further conversion in the matter. Mr. Terrace had quoted some figures which, he was quite sure, were given with the best intention; and, he had no doubt, they were based on facts he had before him. He first of all gave them a saving of 1s. 6d. per ton of coal, by reason of their being able to use small coal. Many of the members would bear him out, he thought, that the average difference in cost between screened and unscreened coal, generally speaking, was something like 1s. per ton. This being so, those of them who were in the habit of using all screened coal, if they could by the introduction of this retort use unscreened coal, might possibly save more than 1s. per ton. In his own case, where the bulk of the coal they carbonized was unscreened, he failed to see that he would get even this saving; and how the 1s. 6d. came in was not very clear. He might, however, be told that they would be able to use an inferior class of coal. Well, if this were so, necessarily the results they would obtain would be inferior to those realized with a good class of coal. He also thought that a saving of 3s. per ton upon labour was rather high, judging from his own results.

Mr. TERRACE pointed out that his statement was 2s. per ton.

Mr. BOWER said the saving would vary materially according to the rate that was paid for labour. If they had a high rate, the saving must necessarily be very much greater than where they had stokers' wages down to 4s. per day. But the item to which he took most exception was that of the additional 2000 cubic feet of gas at 2s. per 1000 cubic feet. What seemed to him to be rather contrary with regard to this was that Mr. Terrace was in the happy position of being able to sell gas at 2s. per 1000 cubic feet; and if he were only getting 2000 cubic feet extra, at 2s., how was he to recover the cost of distribution,

the contribution to the sinking fund, and the profits which he so generously handed over to the borough funds for other purposes? If he were only to obtain a saving of 2s. per 1000 cubic feet into the gasholder, it seemed to him that the figure was altogether too high to make a comparison of that sort. For his own part, he should have put it at half the amount, because he was afraid that, if all the gas produced in the North of England cost 1s. per 1000 cubic feet into the holder at all times, dividends would be very scarce. As to the use of the apparatus for spent lime, he decidedly thought there was something in the future of the appliance for that purpose. It appeared to him that it was particularly suited for revivifying spent lime; and if he should, at any future time, ever be induced to look into the matter with a view to experiment, he should think this would be one of the greatest factors that would influence him to introduce it, rather than to adopt it, in the first instance, for the distillation of coal. There were several other matters Mr. Terrace had touched upon, and given an able explanation of; but it seemed to him, as Mr. Ford had said, from the fact that the results were obtained during a process of carbonization extending over (say) not more than 30 minutes, that they might be very different from what would be realized if the plant had to work for 24 hours or for a week. This was a point which could only be settled by some gas manager getting the plant introduced into his own works, and giving it a fair trial under the usual conditions; and he was in hopes that some of their friends—perhaps Mr. Terrace or Mr. Ford—would, if they were so sanguine of the results, before long introduce it in their works, and give their brethren the benefit of their experience.

Mr. J. HEPWORTH (Carlisle) was sure the Association would be the first to welcome any efforts made with a view to reducing the cost of labour in gas-works, or ameliorating the conditions existing with reference to the labour attached to the operation of stoking. He had listened very carefully to Mr. Terrace's paper; and he thought there were some striking omissions, though it contained a great many facts and statements which were extremely interesting, but which were open to very much criticism. He did not hear any reference made to the cost of the installation itself. The first cost was a primary matter to consider when they came to make deductions as to the saving to be obtained by the introduction of the process. He dissented—in a friendly manner, of course—from some of the statements which were made in the paper as to savings. In the first place, upon the cost of coal, he should think it quite

possible that 1s. 6d. or 1s. might very well be saved. But, if he understood the apparatus aright, they would be compelled to use small coal. If they had coal which contained large nodules, they would be obliged to separate these larger pieces, and, to do this, they must either commence screening, or have a grinding process for reducing the coal to one size. The outlay for this would have to go against the 1s. 6d. or 1s. saved in the first cost of the coal. Then he did not agree with the figures given as to the cost of increasing the value of the gas. It was claimed in the paper that the quality of the gas was enriched to the extent of something like two candles; and Mr. Terrace had stated that about 3d. per candle would be the cost by the ordinary process. Well, he had to enrich gas; but he would not say that it cost him 3d. per candle. A less figure than that should be taken. He was a little dubious about the 2000 cubic feet extra per ton of coal, though he was sure that anything which Mr. Terrace told them would be quite substantiated by his own experience. The sources of damage by the introduction of air had already been pointed out; and one was glad to hear that means were to be taken to prevent such a serious matter. With reference to the continuous working of a retort like this, there would be some danger in having to let down the heat, because of the very delicate joints. The apparatus could never be thoroughly tested until it was put into a gas-works, and operated continuously during the six or seven days of a week. If this were done, the figures which had been given them would have to undergo very considerable revision. With reference to the use of the apparatus for revivifying spent lime, it seemed to him that it would be excellent for the purpose. But, unless it could be done by this process very much cheaper than by other processes, he did not know that it would be of much value. Where they could get lime at 10s. per ton, the apparatus must be a very effective and very cheap one to pay interest on capital, and for labour involved in revivifying.

Mr. W. J. WARNER (South Shields) thought it was due to Mr. Terrace that he should, on behalf of the Committee, say one word with reference to the data that gentleman had submitted. It was the author's desire to have fuller and more reliable data to put before the meeting; and to some extent he hesitated in presenting the paper without more satisfactory particulars than those on which he had had to rely. But the Committee pressed him to bring the paper before the Association. He had done his best; and he (Mr. Warner) considered they could not do otherwise than admit that the result had been satisfactory.

Mr. G. S. SAYNER (Harrogate) said, having heard the paper and seen some of the experiments made with the apparatus, he would just add his testimony that he thought those who had not had the pleasure of investigating the process would find it was somewhat of an "eye-opener" to them, although it was in a form in which the results could scarcely be taken as what would be obtained in practical working. But, even as it was, it was a very decided advance in the distillation of coal.

Mr. B. W. RICHARDSON (Harrogate) asked what quantity of residual cinders was obtained per ton of coal.

Mr. C. D. DRURY (Sunderland) remarked that he had not seen the retort, and therefore would like to put a few questions. One was at what temperature the apparatus worked, and also as to the probable life of it. He also wished to know what amount of the area of the retort was occupied by the charge, because, unless the area were pretty well occupied, he should imagine that stopped pipes would frequently occur. From what he had heard, he supposed that Mr. Terrace would not recommend an installation of these retorts by themselves, but only as an auxiliary to the ordinary retorts.

Mr. TERRACE, replying to the points raised in the discussion, said Mr. Ford had stated some practical objections which he saw; but these were necessarily details, which would be rectified in future apparatus. There was no doubt the appliance was not perfect. As to continuous use, it was a question as to whether it would be better to be always working. He thought, indeed, that a retort was always best when it was continuously in operation. This retort had been working, not for 30 minutes, but for 16 hours at a stretch. The gas was given off by it in 12½ minutes; but they had never had a test which lasted less than two hours. It was a question of heats whether the coal would all require to be of one size. It was impossible to tell by a single retort, exposed to wind and rain; and it would be too bad to throttle an invention of this kind by a single instance. But, if sufficient heat were applied, he thought they could look for the results. The tenor of his paper was that the retort would be an auxiliary; and the figures he gave were tentative. The saving of 3s. which Mr. Bower commented upon was the total gain, of which 2s. was from labour. They would not have any outlay upon the 2000 cubic feet of gas they gained out of the same coal. He thought that the main thing was to get the 2000 cubic feet, and that they would all be very pleased to have it. The cost in the holders was a question which, in his opinion, they need scarcely mix up with this one; it was carbonization

they had to do with. Of course, Mr. Bower was quite right in saying that the 2s. for the 2000 cubic feet was not all gain. As to screened and unscreened coal, what he alluded to was not unscreened coal at all; it was "duff" coal—small coal. He referred to the small coal, but not necessarily inferior coal, though coal which there was difficulty at present in carbonizing. Mr. Hepworth made some reference to the cost of the apparatus. This, he believed, would be something like £600, or about equivalent to the cost of a bed of through retorts. He merely mentioned the matter in a very tentative way in his paper, because he did not pretend to go into many particulars. Mr. Hepworth also alluded to the breaking of the coal. Of course, this would require to be done, because the spiral would not deal with large lumps; but it was necessary to do this for ordinary stoking-machines. The temperature at which the retort was used was just what they would expect an iron retort to be worked at—perhaps up to 1500°. They had to heat according to the material they were carbonizing. When they were passing coal continuously through it, they could easily regulate the heat. The area of the charge would simply be greater or less according to the heat they had externally. There was about 8 cwt. of cinders per ton, although, as he said, they were useless as coke, and therefore he took no notice at all of them.

The PRESIDENT said he confessed he could not see himself where the 1s. 6d. per ton might be saved by using either "duff" or the single screened coal, which would be suitable for this apparatus. He was sure they felt much obliged to Mr. Terrace, and would give him a warm vote of thanks for his trouble.

The proposal was heartily agreed to.

Mr. H. LEES (Hexham) read the following paper, prepared by Mr. Er W. Smith, of Cockermouth, who was unable to be present :—

HISLOP'S REGENERATIVE RETORT SETTINGS, AND EXPERIENCE IN THE WORKING OF SAME.

When I was first approached by our esteemed President with the proposal that I should contribute a paper on Mr. Hislop's regenerative settings of retorts, it was urged that, inasmuch as I was the only one using that system under our English conditions of working, and with softer coal than prevails on the other side of the Border, my experience placed me in such a position that my testimony as to the practicability or otherwise of their

more general adoption would be most valuable. When again pressed to write a paper on the subject, and after a more extended trial of the settings, I consented.

It is now nearly two years since Mr. Hislop's furnaces were introduced into the works under my control. The reasons for the adoption of a regenerative setting were, I think, in my own case—and probably may be in many others—both strong and good. Prior to the time I speak of, our carbonizing plant consisted of three settings of fours, and one each of fives and sixes—in all 23 retorts. The former were set in ovens 6 ft. 3 in. by 10 ft.; and the oven of the bed of sixes was 7 ft. 6 in. by 9 ft.—all being heated by direct firing. I may mention incidentally that the ovens had been in existence over thirty years, and were not in very good order. We had the greatest difficulty in maintaining a fairly good and constant heat, owing partly to the bad state of the arches, and partly to their smallness. Under such conditions, it is not to be wondered at that much irritation and annoyance resulted at times to myself. Any slight neglect or irregularity on the stokers' part in attending to the fires, brought about such a reduction of temperature as could not be easily recovered. These little troubles would invariably occur in a most vexatious manner at critical periods. When, however, it was found necessary to make sundry alterations to the retort-stack, as our sale of gas was increasing, I determined on pressing for the adoption of such a retort-furnace as would require a minimum amount of attention from any of the men, and at the same time tend to relieve me of the necessity of spending the greater part of my time in the retort-house. I should say that I had previously had some experience in the working of regenerative settings; and my attention naturally turned to this type of furnace. But here a difficulty presented itself. Our works are peculiarly situated; and I had reason to fear that, if we had to excavate to the depth required for most regenerative settings, we should encounter trouble with water. There was no getting beyond the fact that, if I was to have a regenerative setting, the producer must be of the shallowest description; and, looking over the various kinds, my attention was most attracted by the one eventually selected—that under Mr. Hislop's patents, and which had worked so successfully at the Paisley Gas-Works.

It may be advisable to describe at this point the settings referred to, and their chief characteristics. One most important feature about them is the comparatively shallow producer and sunk chamber. A reference to the drawings [see pp. 118-19] will

show at once that it is only necessary to excavate to a depth of 4 ft. 10½ in.; while the floor-level of the sunk chamber in front of the settings is only 4 feet below the retort-house floor. The settings adopted at Cockermouth consist of two ovens of sixes. The height of the bench from the floor-line of the retort-house to the top of the brickwork is 10 ft. 6 in.; and the total height from the sunk chamber to ditto, 14 ft. 6 in. The ovens are 8 feet wide by 8 feet high and 10 feet deep; the retorts being 15 in. by 22 in. by 9 ft. 6 in. The division-walls of the bench are carried forward below the floor-level to the front of the sunk chamber, and form supports for the covering-plates and buck-staves, which latter are built about 18 inches into the wall.

In the mode of construction of the producer (which is built inside the oven), the arrangement of the ash-pans, and the provision for the admission and controlling of the air supplies, Mr. Hislop has shown considerable ingenuity and skill; and he is to be congratulated on the happy arrangement he has succeeded in devising. The lower part of the producer is formed of two curved cast-iron plates—the convex side to the inside of the furnace. These are set about 5 inches apart, and are covered with silica blocks; the concave sides of the plates forming the chambers which hold snugly enough the ash-pans, of which there are two—one on each side of the producer. From the top of the ash-pan chamber, the side walls of the producer are started, from which an arch is thrown, extending the whole length of the oven. The total height of the producer is 4 ft. 7¼ in.; the extreme width being 2 ft. 8 in. A gentle slope is given from the back wall of the settings to the body of the furnace, as shown in the sectional drawings. When in action, carbon monoxide is produced abundantly, and escapes from the producer by means of openings at regular intervals on each side of the arch, and extending the whole length thereof.

The combustion chambers into which the producer gases are admitted, are situated one on each side of the furnace, and between the two bottom retorts. The secondary air supply is admitted to the regenerator flues by means of the two apertures situated near the bottom of the front wall, and is easily regulated by means of the sliding discs. Passing backwards and forwards several times, "sandwiched" between the side wall of the producer and the return flues from the setting above, the secondary air acquires a considerable rise in temperature before meeting with the gases leaving the producer at the combustion chamber. It may be well to direct your notice to the fact that the secondary air enters the combustion chamber at the bottom;

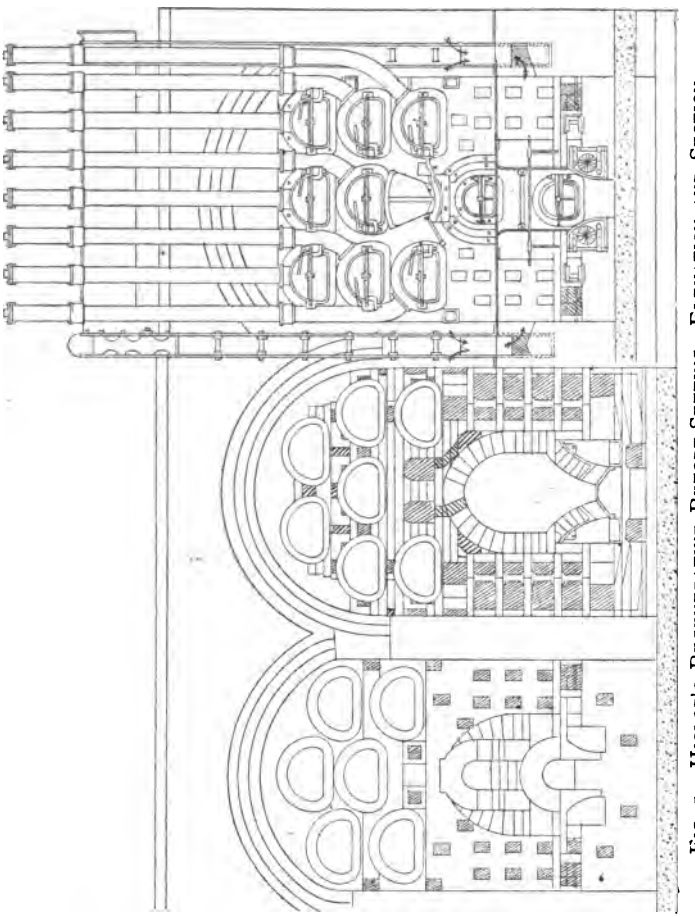


FIG. 5.—HISLOP'S REGENERATIVE RETORT-SETTING—ELEVATION AND SECTION.

the producer gases entering at the side. Mr. Hislop, I believe, claims for this arrangement a more regular, steadier, and complete combustion throughout the chamber.

The producer—as, indeed, all the brickwork, such as the combustion chamber, &c., exposed to the direct action of the heat—is constructed of blocks containing a large percentage of silica, to withstand the action of very high temperatures. I have not the means at my disposal for ascertaining the degrees of heat attained; but I may say that, throughout not only the combustion chamber, but the setting and retorts generally, a most even and beautiful temperature prevails. The spent heat

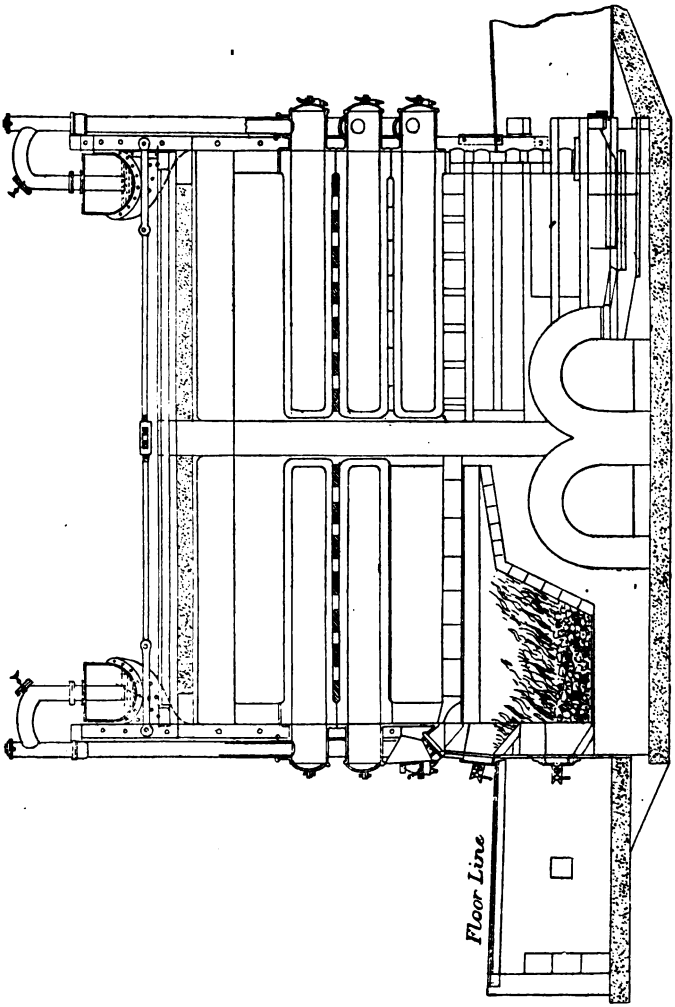


FIG. 6.—HISLOP'S REGENERATIVE RETORT-SETTING—CROSS SECTION.

leaves the ovens by means of the flues on each side, and next to the side walls, travelling backwards and forwards as it descends, divided only from the regenerator flue by 3-inch tiles (as shown), until it reaches the exit openings to the main flue. The latter is situated under the retort-bench; and each oven is provided with four openings, one on either side of the furnace serving for the flue which runs under the ash-pans. A portion of the spent heat is conducted, by controlling the

upper exit, to the lower flue; thereby compelling it to do extra duty in the evaporation of the water required for the proper formation of friable ash, instead of hard clinker, and to otherwise assist towards the efficiency of the furnace, by allowing itself to be split up into its component gases.

The primary air supply is admitted through circular openings in the ash-pan door, easily regulated by discs; and, as it passes on to the side ports leading from the ash-pan chamber to the producer, it carries along with it the water vapour, which is constantly generated by the waste heat under the pans.

The front of the producer is covered and strengthened, besides being rendered perfectly air-tight, by means of a cast-iron plate, provided with two doors—one being above the level of the flooring plates, the other near the bottom of the furnace. The latter is used for raking out the friable ash and clinker; the upper one serving to enable the stoker to break through the arch of clinker (which always forms), and to level up the charge of fuel after replenishing. Both these openings are faced, as are also the doors, to form a tight fit when screwed up.

Immediately above the producer, you will notice there is shown on the drawing the funnel-shaped hopper, which, when not required for use, fits very neatly under the mouthpiece of the bottom retort. During the operation of drawing the charge of coke from the retort above, the hopper is liberated and falls back, disclosing the mouth of the producer. After the charge is drawn, the hopper is pushed back to its place, and the producer lid closed again, with ease and facility. It is found, in the case of sixes, such as we have at Cockermouth, that the fuel from the two retorts is more than sufficient—one retort alone will almost suffice. When the doors are all shut and closed tightly, nothing further requires to be done for four hours. The combustion of the coke is most complete; leaving only a small residue of ash and clinker, which latter forms a rough kind of arch, extending from the front of the furnace to the back, the under side of which is in a line with the upper portion of the bottom door. The operation of cleaning is carried on easily, and with very little inconvenience to the workmen. I may add that we have not found it necessary to clean out oftener than once every 48 hours; and for several weeks at a time, when the retorts have not required to be pushed, we have only had to clean out once in three days. I need scarcely point to the advantages resulting from a setting that requires so little attention in the charging and controlling of the furnace, as does the one under consideration.

When the furnaces were first lit up, the usual process and interval of drying was gone through, and the period between the charges of fuel gradually shortened, until sufficient heat was obtained to burn off a charge of coal in four hours. We have had no difficulty in maintaining the four-hour duration—indeed, I may say that, were it necessary, we could easily obtain sufficient heat to carbonize our charge of soft coal in three hours, as is done with the splints and shales in Scotland. So far, we have experienced no difficulty, and samples have been tried ranging from rich cannels, splints, caking coals, &c., down to the compound for curing stopped ascension-pipes.

The consumption of fuel is exceedingly low—working out to something like 17 or 18 per cent. of the total quantity of coke made, or a little more than 11 lbs. per 100 lbs. of coal. I give the two figures advisedly, as there is some liability to confusion if either one is mentioned alone. While dealing with the fuel account, it may not be irrelevant to state that it is the practice of some managers to determine the quantity of fuel used by deducting the coke sold from the quantity afforded per ton as found by analysis, which is most fallacious, since the coke sold contains a considerable weight of added water, with the result that the quantity left, as used by the furnaces, is reduced to the extent of the weight of water added to the coke sold. This would particularly affect the percentage of fuel used in a works where there is a ready sale for coke; and it affords a means for colouring up statements which mislead many.

So far as my own experience goes, the greatest advantage and saving have been derived from the increased yield of gas per ton of coals over the old order of working, as shown by the following figures:—

Quantity of Gas Made, Coal Used, &c., from the Beginning of October to the End of March in the following Year.

Coal Used.	Gas Made.	Average per Ton.	Wages for Carbonizing.	Cost per 1000 Ft.	Cost per Ton.
1890-1. 1989 ..	18,466,800 ..	9,311 ..	£224 8s. 11d. ..	2·91d. ..	2s. 3·08d.
1892-3. 2004 ..	20,926,300 ..	10,495 ..	191 19 9 ..	2·20 ..	1 10·98

The increased yield per ton represents a saving of coals to the value of £146, or 1s. 5·50d. per ton. Add to this the saving in wages 4·10d., and the saving in fuel, which, at the lowest estimate, cannot be less than 15 per cent. upon the old and exceedingly wasteful system we previously worked under. The saving under this head comes to £97, or 11·61d. per ton of coals carbonized; showing a total saving of 2s. 9·21d. per ton enjoyed by the working of a well-arranged regenerative setting. But this

is not all, as we are told, with reason, that gaseous firing adds considerably to the life of a retort; thereby enabling it to produce more gas during its lifetime than if it had been subjected to the cutting heats of a direct open fire. So far, I have not had any of our retorts renewed; but, while on a visit to Paisley, I was informed that, when renewals are carried out, it will not be necessary to interfere with the producer or regenerator, as they are found to remain good for many years.

It should be stated, in justice to Mr. Hislop, that the settings at Cockermouth have not had an opportunity of showing off their advantages to the fullest extent. At no time have we required to carbonize more than 15 cwt. of coal per retort per 24 hours; that quantity in each of twelve retorts being sufficient to produce gas enough to meet our heaviest demands. It should also be strongly impressed that the coal used is a local one, and very much inferior in quality to Durham, Newcastle, and other gas coals. Under more favourable conditions, therefore, much better results than I am able to put before you could be obtained. With retorts 22 inches by 14 inches by 9 feet, Mr. Hislop tells me that, in settings of eight, he carbonizes 26 cwt. of coal per 24 hours, working three-hour charges.

Within the last few months, I am given to understand, the patentee has effected several minor alterations and improvements—notably the substitution of a cast-iron plate over the flue under the ash-pans, instead of the tile shown on the drawings; thereby obtaining a more rapid evaporation of water in the pans. I have found no difficulty from this source.

I feel that my paper would not be considered complete without some allusion to the cost of the settings; and I beg therefore to give briefly the terms quoted by Mr. Hislop for the supply and erection of the several settings as follows:—

For ovens of eight retorts complete (including all iron-work, such as mouthpieces, &c.) from foundations, and allowing bricks at 75s. per 1000		£287
Do.	Sevens	272
Do.	Sixes	250
Do.	Fives	229
Do.	Fours	203
Do.	Threes	190
Do.	Twos	156

To which a royalty charge of 30s. per retort is made in each case, and which covers the provision of all detail matter for the completion of the work. I may state further that the figures which apply to my own particular case—for settings of sixes—are borne out by the actual charges incurred.

It may be urged that, after all, the earlier principle of regeneration, as carried out by the late Sir William Siemens and others, is noticeable in the arrangement of the flues, &c., in the settings before you. But, while not admitting this, I think it should be remembered that there was, to say the least, room for improvement; and in the general arrangement and development of the form of regenerative furnace as designed by Mr. Hislop, there is (considering the comparatively short time that has elapsed since the introduction of this system of firing) almost as much difference as between the earlier forms of locomotive engines and those running at the present day.

The PRESIDENT said he was very anxious that the paper should be read, because he knew that several of the members were "halting between two opinions"—the question being what system they were to adopt.

Mr. HEPWORTH suggested that, as Mr. Smith would probably be present at the next meeting, it might be advisable to postpone the discussion upon the paper till then. He moved accordingly

This was agreed to.

NEW MEMBERS.

Mr. G. S. Sayner (Harrogate) was elected a member of the Association; and Mr. Herbert Kindler (Stockton) an Associate.

ELECTION OF OFFICE-BEARERS.

It was intimated that the following gentlemen had been elected to hold office in the ensuing year:—

President—Mr. D. Terrace, of Middlesbrough.

Vice-President—Colonel Sadler, J.P., of Middlesbrough.

Auditor—Mr. J. H. Penney, of South Shields.

Secretary and Treasurer—Mr. W. Hardie, of Newcastle.

Committee—Mr. H. Tobey, of Malton; Mr. H. Lees, of Hexham; Mr. J. Nichols, of Darlington; and Mr. J. Whyte, of Seaham.

Mr. TERRACE thanked the members for electing him President, and assured them that, with the assistance of Colonel Sadler, who was an Alderman of Middlesbrough, he would do his best to give the members a hearty welcome when they met in that town in the autumn.

A vote of thanks was then passed to Mr. Whyte for his services as President, and the business concluded.

The members afterwards dined together in the County Hotel.

MANCHESTER INSTITUTION.

QUARTERLY MEETING, MAY 13.

This was the Excursion Meeting of the Institution; and it was attended by nearly seventy members and visitors. Meeting at the Central Station, Manchester, the party travelled in saloon carriages, attached to the 10.20 a.m. train, to Northwich. There they lunched at the Crown and Anchor Hotel. When the Institution visited Northwich five years ago, the programme included a visit to a salt mine, and inspection of the Anderton hydraulic lift, by which boats are transferred from the River Weaver to the canal, which is at a much higher level. This time Northwich was the starting-point for a journey down the Weaver to its junction with the Manchester Ship Canal at Saltport; and thence down the canal to Eastham Locks. This trip was most enjoyable. The Weaver pursues a winding course through diversified scenery; and after Northwich and its chemical works were left behind, the voyage was delightful. The distance from Northwich to Saltport is some 15 miles; and the length of the Ship Canal then traversed, about 12 miles. Much interest was taken in this first completed section of Manchester's great undertaking, which most of the party passed over for the first time. The voyage, made by steamer, occupied the whole of the afternoon. On arriving at Eastham, the party had tea at the Ferry Hotel. Subsequently they crossed to Liverpool, and returned to Manchester by train. Throughout the day the weather was delightful; and the arrangements made by the Hon. Secretary (Mr. Samuel S. Mellor, of Northwich) for the comfort of the party proved completely successful.

The business part of the day's proceedings occupied a very few minutes at the close of the lunch at Northwich. The President (Mr. W. R. Chester, of Nottingham) occupied the chair. The minutes of the last meeting were confirmed; and one new member—Mr. T. N. Ritson, Manager of the Kendal Gas and Water Company—was formally elected.

MIDLAND ASSOCIATION.

QUARTERLY MEETING, MAY 25.

The Spring Meeting of this Association was held at Worcester, and was exceptionally well attended. By the courtesy of the Directors of the Worcester Gas Company, the members met in the Board-room at the gas-works for the transaction of the little more than formal business on the *agenda*. Mr. B. W. Smith, of Smethwick (the President of the Association), was in the chair; and on the opening of the meeting Mr. E. L. Adlington, the Manager of the Worcester Gas-Works, offered the members, on behalf of the Directors, a cordial welcome to the "faithful city of Worcester." Among the matters which came before the meeting was a communication from the South-West of England Association, forwarding the resolutions which that body had passed as to the desirability of having a federation of the various District Associations, together with The Gas Institute and the Institution of Gas Engineers; and inviting the Association to send two representatives to a conference in London on the subject. A brief discussion took place upon it. Mr. Lewis (Wellingborough) moved a resolution that the Midland Association, without expressing any opinion as to the desirability or otherwise of a scheme of federation, would appoint two representatives to confer with the other Associations on the subject. Mr. Peaty (Burslem) seconded the motion, which was carried; and the President and the Hon. Secretary (Mr. C. Meiklejohn, of Rugby) were appointed for the purpose. After the business, the members inspected the different departments of the gas-works, and had an opportunity of seeing some of Drake's generator furnaces at work. Subsequently they were entertained by the Directors to luncheon at the city offices of the Company. Mr. J. Stallard presided. The rest of the day was pleasantly filled up by a visit to the Worcester Royal Porcelain Works, a trip on the River Severn in a steamer provided by the Directors of the Gas Company, and "high tea" at the Hop Market Hotel.

SOUTHERN ASSOCIATION.

QUARTERLY MEETING, MAY 25.

This was the Excursion Meeting of the Association; and the members spent a long, but very profitable and enjoyable day, in getting through a mixed programme, that began with a gas-works inspection at Vauxhall and ended at the Mitre Hotel, Hampton Court. The President of the Association (Mr. C. C. Carpenter) had made special arrangements for showing the points of technical interest in the construction and management of the Vauxhall station of the South Metropolitan Gas Company; and consequently this part of the day's proceedings was much appreciated by the visitors. The Vauxhall works occupy a cramped and awkward site, the proximity of which to the residential area of South-West London renders careful administration imperative. The problem of purification becomes a difficult one under such conditions; but Mr. Carpenter was able to demonstrate, that it is possible to treat lime-boxes so as to render the spent material, in his own expressive phrase, "dead." The boxes are kept warm, if required; and the water in the lutes is covered with a protecting layer of oil. The same device is followed for all seals and traps that might give off an odour. Mr. Carpenter's retort-settings were well exhibited; some of the arches being lit up with gas inside, to show the flue arrangement. The gas manufactured at Vauxhall is stored at Kennington Lane, whither the members were conducted, in order to inspect the enlarged gasholder, which had not then, however, been raised above its guiding framework. Here luncheon was provided by the Directors of the South Metropolitan Gas Company, represented by Mr. R. Morton. The party subsequently went from Vauxhall Station to Hampton Court Palace, *viâ* Teddington and Bushey Park; and, by permission of H.M. Chief Commissioner of Works, they were shown everything there is to be seen in and about the historic buildings and grounds. "High tea" at the Mitre Hotel ended the day. The arrangements, in the capable hands of Mr. James W. Helps, the Hon. Secretary, were perfectly planned and most successfully carried out.

NORTH BRITISH ASSOCIATION.

ANNUAL MEETING, JULY 27 & 28.

This Meeting was held in the University College Buildings, Dundee—Mr. T. DOUGLAS HALL, of Montrose (the President), in the chair. There was an unusually large attendance.

The PRESIDENT, in opening the proceedings, expressed the gratification of the Committee at seeing so many members present.

THE COMMITTEE'S REPORT.

The SECRETARY (Mr. R. S. Carlow, of Arbroath) then read the report of the Committee, which, it was stated, was presented in the form agreed on at the 1885 meeting. It gave a general outline of the business done, with some notes that might be interesting. The Benevolent Fund in connection with the Association had been drawn upon largely during the past year —£45 having been paid to five deserving cases. The Annual Report of Proceedings, 1892, was published, and sent to each member of the Association, according to the rules. It contained the President's address, papers and discussions thereon, a list of the Past-Presidents, new members admitted, names of members of Committee, rules, balance-sheets, &c., &c. The Statistical Report for the year ending the 31st of July, 1892, was compiled and bound together with the Annual Report of Proceedings for 1892, and issued to all members of the Association, as well as to those who gave the necessary information. The Committee had to report that, in terms of the motion made by Mr. James B. Terrace, of Brechin, application was made, on behalf of the Association, to the Royal Society, Burlington House, London, for a grant of £30 for aiding a fund for research purposes in connection with the manufacture and distribution of gas. They were, however, sorry to state that a communication had been received by the Secretary of the Society, stating that the Government Grant Commissioners, after considering the same, were not prepared to recommend that it be granted. The Committee had also to report that they visited the Peebles Gas-Works on Wednesday, May 17,

for the purpose of inspecting and reporting on the process carried on there of manufacturing gas from oil. The Committee were met at the works by Messrs. Young and Bell; and they were shown over the whole works, and inspected all the appliances and plant in connection with the making of gas from oil, as carried on at Peebles. They received from Mr. Young a full and detailed statement as to the working out, and the practical results obtained from this process of making gas from oil. Mr. Young and Mr. Bell, before the Committee left the gas-works, kindly agreed to read papers on their oil process of gas making at the present meeting; and the Committee therefore considered that a report from them, in the meantime, would to a certain extent forestall the papers to be read by Mr. Young and Mr. Bell. They, therefore, had considered it advisable to postpone giving any opinion upon the Peebles process of making gas from oil until after Mr. Young and Mr. Bell had read their papers; but those of the Committee who had the pleasure of seeing the process at work would be better able to join in the discussion which would no doubt take place on these papers.

REPORT OF THE RESEARCH COMMITTEE ON "COAL ANALYSIS."

In conformity with the motion proposed by Mr. M'Gilchrist at last year's meeting, on Mr. M'Crae's paper on the above subject—"That the Research Committee should be instructed to report on the subject to the next annual meeting," and which motion was unanimously agreed to, the Committee had to report that, bearing in mind the great importance of the subject, and also of the many questions involved, they had given a considerable amount of time to its consideration; and they had several meetings and consultations thereanent. It was their desire to exercise such caution as to ensure that their deliberations would meet with the general approval of their fellow-members of the Association. They felt, for one thing, that consideration of the subject had been too long delayed. They felt also that the absence of any reliable data as to the practical value of coals for gas-making purposes had been the cause of much anxiety and trouble to gas managers generally, as well as to their employers, whether as companies or corporations. Believing this to be the case, the Committee set themselves to put forward to the gas world a few conditions which should guide all purchases of gas coals, and which, if faithfully acted up to, would do away with much of the dissatisfaction which had been so apparent in times gone by. The conditions might

be considered by some as being insufficient either in number or in severity. But the Committee submitted that, as presented, they carried on their face, simple practical rules which should guide practical men—be they buyers or sellers, of the article under consideration, or indeed any other kind of merchandise. They were harsh to no one; and, if carefully considered by all, they should be accepted as being just, reasonable, and right. The conditions suggested by the Committee were as follows—

(1) The fallacy of depending on printed analyses as recently issued because, to obtain the practical value of any coal, from 20 to 40 per cent. must be deducted from such printed analysis.
(2) To condemn the custom of changing the name of any individual coal.
(3) To discard giving the coal any other name than that of the pit from which it was drawn; also the name of the colliery.
(4) That all analyses should be conducted on a thoroughly practical scale; and that the coal analyzed should be treated in precisely the same manner as such coal would be subjected to in gas-works.
(5) That every sample drawn for examination should be taken from a lot equal in weight to at least 5 tons; and further, before the sample was drawn, the whole 5 tons should be broken and thoroughly mixed, and from which mixture the sample ought then to be taken.
(6) To state on the face of the analyses whether or not an exhauster had been used, and the quantity of coal used for each test.
(7) That suitable burners be used to test the various qualities of gas for various analyses; and that the burner employed be described, and the pressure at which the gas was consumed.
(8) That a copy of this report should be sent to every coalmaster and coal merchant in Scotland who supplies gas-works with coal or cannel.

These were the conditions the Committee recommended; and they considered they spoke for themselves. But, at the same time, the Committee requested the hearty co-operation of the members in carrying the conditions into effect.

The PRESIDENT said the Committee, at their meeting that morning, had the report on "Coal Analyses," before them, and very carefully considered it; and he thought the members would be quite safe in adopting it.

The report was adopted without remark.

NEW MEMBERS.

The SECRETARY submitted the names of the following gentlemen for election to membership:

ORDINARY MEMBERS.

Bowman, J. . . .	Gas-Works . . .	Huntley.
Cay, J.	,, . . .	Keith.
Ewing, W. . . .	,, . . .	Hamilton.
Fox, W.	,, . . .	Lerwick.
Guthrie, J. . . .	,, . . .	Lochgelly.

Hislop, L.	Gas-Works	Uddingston.
Marr, W.	„	Stonehouse.
Marshall, W.	„	Banff.
Munro, J.	„	Crail.
Myers, N. J.	„	Saltcoats.
MacPherson, J.	„	Cupar, Fife.
M'Alpine, A.	„	Troon.
M'George, W.	„	Comrie.
M'Lusby, W. B.	„	Kirkcudbright.
M'Pherson, J.	„	Beith.
Peacock, T.	„	Carluke.
Pooley, H.	„	Dunfermline.
Renfrew, J.	„	Mid Calder.
Robb, J.	„	Kirkwall.
Robertson, A.	„	Alyth.
Scott, A.	„	Laurencekirk.
Smith, W.	„	Melrose.
Stevenson, A.	„	Skelmorlie.
Thomson, R. B. H.	„	Broughty Ferry.
Turner, T.	„	Airdrie.
Waddell, F.	„	Blairgowrie.
Whyte, W.	„	Penicuik.

EXTRAORDINARY MEMBERS.

Gillespie, A.	Gas Engineer	Glasgow.
Little, G.	„ „	London and Aberdeen.
Russell, A.	Colliery Agent	Glasgow.
Slight, J.	„ „	Glasgow.

ASSOCIATES.

Anderson, E. E.	Gas-Works	Old Kilpatrick.
Dewar, J.	„	Paisley.
Sharp, R.	„	Belfast.

The membership showed an increase of 17—from 222 to 239—and is made up of 160 ordinary members, 59 extraordinary members, 14 associates, and 6 honorary members.

The Murdoch Memorial Fund.

Mr. J. M'Gilchrist (Dumbarton) reported that the Murdoch Memorial Fund consisted of a deposit receipt for £200, and a current account for £2 9s. 9d. The expenses connected with the unveiling of the bust of Murdoch at Stirling had been met; and, after all of them had been paid, there was the above sum to the good. It had been suggested that in the current year an attempt should be made to raise £300—making the sum £500—so as to found a bursary in connection with the name of Murdoch. He hoped that this time next year would see this an accomplished fact.

On the suggestion of the President, Mr. M'Gilchrist was re-elected as Secretary and Treasurer of the Memorial Fund;

Mr. M'Crae and Mr. MacPherson being appointed a Committee to act with him.

THE AUDITOR'S REPORT.

Mr. R. B. MAIN (Glasgow) then submitted the balance-sheet of the Association, which showed a total income of £192 17s. 10d., of which £65 12s. was derived from annual subscriptions; and that there was a sum due to the Treasurer of £22 10s. 8d. The Benevolent Fund showed annual subscriptions amounting to £25 16s.; a total amount of £272 15s. 8d.; an expenditure of £45 in grants; and other expenditure amounting to £11 5s. 4d. The Research Fund showed annual subscriptions amounting to £7 10s.; and a total amount (including £70 on deposit receipt) of £90 6s. 11d. The expenditure was £16 8s. 5d.

The PRESIDENT said that, at first sight, the balance-sheet might not look a promising one; but, on close inspection into the figures, he thought it was very creditable. He believed, at all events, that Mr. Carlow saw his way to have the balance on the right side next year.

The balance-sheet was adopted; and Mr. Main was accorded a vote of thanks for his services.

THE PRESIDENT'S ADDRESS.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—In opening the proceedings of the thirty-second annual meeting of the North British Association of Gas Managers, my first duty is to thank you for the honour you conferred upon me in electing me as your President for this year; and I trust, now that my duties are nearing their most important crisis, I shall be able to bring my year of office to a successful termination. Let me here express a hope that the work has been carried out in such a manner as to maintain the good position of the Association. Apart from the personal honour, I consider my selection as a compliment to managers of medium-sized gas-works.

Managers of small works have their troubles, their anxieties, and their successes, just the same as those who control large works; and I speak from experience when I say that it requires quite as much care to manufacture 10 million cubic feet of gas per annum, as it does to make 200 millions. The same care and skill are required to navigate a ship of 50 tons burden across the ocean as to manage one of our huge Atlantic greyhounds.

Although much of the success of such a gathering as the present must necessarily depend on the President, yet each of

us has it in his power to contribute something towards success, by taking part in the discussions and favouring his fellows with the benefit of his experience. Particularly would I ask the younger members, upon whom eventually must devolve the work of this Association, to manifest a keen and lively interest in our proceedings to-day.

At the outset, let me refer to the sad and severe loss the Association has sustained this year in the death of four of its members—members who not only had the interest of the Association at heart, but who took an active part in its practical work. Mr. John Somerville, Engineer of the Bankside station of the South Metropolitan Gas Company, passed away after a few hours' illness, on the 15th of December, 1892. In him we lost one of the best known, most popular, and ablest of leaders in the gas world. Mr. William Mackenzie was a gentleman who had only to be known to be respected. He died on the 11th of April last; and he was one of our oldest members. If not the originator of this Association, Mr. Mackenzie was one of the first to join its ranks. He was appointed Secretary at the first meeting of the Association, held in Cupar in 1862—he being at that time Manager in Cupar—and he faithfully served the Association in that capacity for 21 years. Under his presidency, a most successful meeting was held in Edinburgh in 1882; and at the meeting at Perth in 1890, we saw and heard the last of him. Mr. Mackenzie endeared himself to us all by his quiet, courteous manner, and his zeal for the welfare of the Association. The circumstances attending the death of our friend are particularly sad, seeing that only a few weeks previously he had intimated his resignation, and was looking forward to a well-earned rest. Mr. Laurence Hislop is the third gentleman to whose death reference should be made. He was one of the Vice-Presidents of this Association, and was a constant attendant at our meetings. He was a Member of Committee for many years, and took a deep interest in the business of the Association. It is a strange coincidence that he passed away on the same day as Mr. Mackenzie, and that on the day of our last Informal Meeting the announcement of both deaths appeared in the morning papers. Yet another loss falls to be chronicled by me —the death of Mr. John Head, on Friday, July 14. Mr. Head was an extra-ordinary member of the Association, and not a stranger to us. He was present at our 1885 meeting in this building, and took part in a discussion on regenerative furnaces —a system of which he was a known and able exponent; and his long connection with the Siemens firm secured for him a

wide acquaintance among gas engineers. At the time of his death, Mr. Head was Manager to Mr. Frederick Siemens in London. The Secretary had a letter from him so recently as the 7th of July.

One or two of our oldest members have during the past year retired from active service as gas managers; and while they still retain their connection with us, it is a question for consideration whether the Association should not confer some honour upon them. It is pleasant to note that the Boards those men had so long and faithfully served have done something to make the evening of life somewhat easy for them.

It is now eight years since the Association met in this prosperous city; and no doubt we all have pleasant recollections of that successful and enjoyable meeting, and of the able way in which our esteemed friend Mr. John M'Crae conducted the proceedings. The statistics relating to the gas supply of a city like this sufficiently gauge its prosperity or otherwise now. In the year 1869 (24 years ago), when the Dundee Commissioners acquired the gas-works, the annual make of gas was about 200 million cubic feet, and the price was 5s. 4d. per 1000 cubic feet. In 1885 (eight years ago), when we last met here, the make of gas had increased to 400 million cubic feet; and the price had been reduced to 3s. 6d. per 1000 cubic feet. This year, 502 million cubic feet have been manufactured; and the price has been reduced to 3s. 2d.—the lowest price that gas has ever been sold at in Dundee. The revenue and expenditure of the Gas Commissioners are the largest of any public board in the city. From £39,000 in 1869, it has risen in the past year to £100,000. Not only does Dundee possess modern and efficiently equipped gas-works, but a complete and beautifully equipped electric light station, the property and under the control of the Gas Commissioners. With their usual kindness and liberality, the Commissioners have invited the members of this Association to inspect both these works; and I am confident that, as the result of our visit, the only conclusion we can arrive at will be that in respect of artificial lighting Dundee is second to no other city. It reflects credit on the Commissioners that they offer to supply the ratepayers with either gas or electricity. Here we have clear proof that there is no spirit of antagonism between the suppliers of these two sources of light.

At present the electric light installation is capable of supplying 6000 lamps of 16-candle power; and it can be extended so as to supply 25,000 lamps of the same power. About £30,000

have been expended on the station. I do not mean to condemn, nor do I mean to justify, public boards spending such large sums of money "on that which is not bread." Electricity has not yet proved itself to be anything more than a luxury; and gas has become a necessity. This, however, is an age of progress; the great Niagara Fall itself, with nine million horse power, is becoming "a slave to the lamp" electric. It is to be hoped the Dundee Gas Commissioners, in their wisdom, will make the electric light department stand on its own legs. As in the case of gas, those who use electricity should be required to pay for it.

I cannot close these notes on the city we meet in without reference to the water supply. It is one of the finest in Scotland. Through the kindness of the Water Commissioners, who have placed their beautiful properties both at Lintrathen and Monikie at our disposal, we are to-morrow, with our lady friends, to be privileged to view the lovely grounds of Monikie, the source of an unlimited supply of sparkling water.

Passing from these local to more general subjects, I will not dilate on the difficulty of preparing a presidential address. But I may say that no less than nine presidential addresses have been reported in our technical journals within the past six months; and these have touched every question of interest in gas manufacture. It is impossible for me, therefore, to introduce any fresh feature or fact to you to-day. Federation of Gas Managers' Associations alone can cure this state of things; and no doubt future Presidents will be truly thankful if only one address per annum has to be reported, and possibly the readers of our journals will not be sorry.

Seeing we have so many interesting papers on the agenda, I shall only point you to a few matters that in my opinion are worthy of consideration and study. It has been repeatedly said, but unjustly I think, that the ways and means of producing gas from coal have not been so progressive as those of other industries. Ever since Murdoch sat ruminating at his fireside in Cross Street, Redruth, and saw the jet of pale brown smoke issuing from the glowing coal, and conceived the idea of converting his "churchwarden" into a gas-retort by applying heat to it, coal has been destructively distilled by heat. Murdoch's first retort was a "clay pipe;" our retort of to-day is also a clay pipe. The same may be said of steam. Since Watt observed the puff of vapour issuing from his mother's kettle, steam has till now been generated from water by heat. Those of us who had the privilege of seeing the magnificent range of gaseous-fired boilers at the Govan Iron-

Works some years ago, must admit that progress has been made in the ways and means of producing steam; and the same may be said of coal gas. If we look round one of our modern retort-houses, we shall see tier upon tier of retorts. But where are the furnaces we were so familiar with? These furnaces, we know, have given place to the regenerator underneath the charging-floor; leaving clear space for other operations. I would, in this connection, direct attention to the retort-houses at the Dawsholm and Temple Farm works of the Glasgow Corporation, with their 1350 retorts and hydraulic drawing machines, as well as the arrangement at the Aberdeen Corporation Gas-Works (so ably described by Mr. West some years ago), with its endless-rope movement, power charging and drawing machines, and powerful coal-breakers. And, lastly, I would call your attention to the new retort-house at Middlesbrough, so recently described by our friend Mr. Terrace, its designer. Truly these are new departures in retort-houses. In no section of a gas-works is there more sign of change at the present time than in the retort-house. Possibly, were we to return to this sublunary sphere in the course of another century, we should no more recognize the retort-house of the future than would Murdoch recognize that of the present day.

As stokers give way to manual machines, so the latter in their turn give place to hydraulic, steam, and power charging and drawing machines. They again appear as if they were to be supplanted by inclined retorts. It may also be that these will give place to revolving retorts, rotary machines, or web retorts, which, when perfected and proved, may produce for us a continuous process of coal carbonization in practically closed vessels.

It is needless for me to refer in detail to the methods now in vogue for removing all traces of ammonia from the gas, or to the different processes of purification. But I may say that purification in closed vessels—the dream of gas managers—is now nearly accomplished; and the days of "blue billy" in any form must surely be consigned to the limbo of the past.

Gasholder construction has grown with the growth of the industry. We have holders now of six lifts, 180 feet high, and containing 12 million cubic feet of gas. For 60 feet, the one to which I refer stands clear above the guide-framing. That is the famous East Greenwich gasholder, erected for the South Metropolitan Gas Company, London, which is the largest holder in the world. Notwithstanding its immense proportions, it was erected and completed within twelve months; and it now

stands, after about a year's working, one of the triumphs of gas engineering. Another large holder will soon form a conspicuous object in the landscape near Glasgow, at the Temple Farm works, Maryhill. This holder we were privileged to inspect a few months ago.* Its guide-framing and lattice-work reaches to a height of 138 feet; and when full it has a capacity of 6 million cubic feet. When we compare these huge structures with those of fifty years ago—cooped up in massive buildings of stone, in case they should burst and scatter death and destruction all around—we can honestly affirm that we have progressed. The question suggests itself: Shall we stop at a 12 million cubic feet gasholder? Before leaving this topic, I would refer to a nove and ingenious method of regulating the pressure, which has been applied by Mr. A. Smith, of Aberdeen, to a holder some distance from his works. It was necessary to fill this holder during the day from the street mains, without giving undue pressure, and also to maintain the necessary pressure at night. He accomplished this object by means of an annular water balance-tank. Water is pumped into this tank, and the pressure given by the holder is reduced to about an inch. On the tank being emptied, 3 inches of pressure can be had if required. The arrangement is said to work well; and I think that it reflects much credit on its designer.

With respect to condensation, we know that temperature is of the greatest importance in all chemical actions. At low temperature, action ceases altogether. Owing to the irregularities in the quantity of gas manufactured, and to our variable climate, it is a difficult matter to obtain condensation without taking extra precautions. These I would try to point out to you, more especially as applied to small gas-works. Too rapid condensation of coal gas causes loss both in quantity and quality. It is therefore not only desirable, but necessary, that we should have our condensing apparatus thoroughly under control. If the temperature of the gas be too low, we remove the illuminating constituents; and if it be too high, we retard the action of the scrubbers. Accordingly, it is necessary that we should carefully and constantly note the temperature of the gas, both at the inlet and the outlet of the condensers; and, if possible, secure a temperature of not less than 50° at the inlet. All condensing apparatus should be protected from the influence of intense cold or excessive heat; yet how rarely do we find this state of things? Again, the apparatus should be capable of

* See *ante*, p. 86.

being regulated or bye-passed. In many works there are no means of doing this. In such a case, I would suggest that the liquor should be run off, and the gas allowed to pass clear through; for, as a rule, the condensing plant in small and medium-sized works is too large, especially during winter, and even when the make of gas is what we might call large, the volume is too small to retain the temperature above that of the atmosphere, which at times remains for weeks under freezing-point, and occasionally we have such temperatures as 15° to 20° Fahr. The result of reducing the temperature of the gas to these points may be imagined. Not only is there a loss of illuminating power, but the purifiers are sometimes completely disarranged. In my own case, I have a good-sized and lengthy foul main, and am able during severe weather to bye-pass my condensers. I would advise managers of small works to increase the length of the foul main. The condensers, as a rule, are large enough; and we rarely hear of an extension of plant at this point, provided the foul main is long enough. If no means of bye-passing exist, then unseal. Something may be accomplished by running off the liquor. If this cannot be done, cover up the condenser well with an old sail. Covering the purifiers in winter greatly aids the actions and reactions that go on in the apparatus. I would certainly say that all purifiers should be under cover; and, if possible, the condensers also.

A very few statistics will suffice to show the magnitude of the industry we represent—an industry with an unbroken record of over a hundred years, and one that to-day shows more vitality than ever it did, in spite of all opposition from rival sources of light. The estimated capital employed in gas manufacture in this country has reached the large sum of £65,000,000. The quantity of gas sold in London amounts to 30,000 million cubic feet; and the consumption of gas in the United Kingdom during 1892 reached the high figure of 100,000 million cubic feet—showing an increase of 50 per cent. during the past ten years. The coal used in this country for gas alone amounts to about 13 million tons. These figures only give a vague idea of the true magnitude of our industry; and they do not lead to the conclusion that it has reached its highest point.

The next matter with which I propose to deal relates to the raw material we employ. Not many years ago, this would have been expressed by the word "cannel" or "coal." Not so to-day. Oil now plays an important part in the manufacture of gas. The extent to which it is so employed may be gathered from the fact that in six months the South Metropolitan Gas

Company used 154,000 gallons of oil, representing 77,000 tons of cannel coal; and The Gaslight and Coke Company used 74,000 gallons, equal to 37,000 tons of cannel coal. The use of oil was the result of the exorbitant price which coalmasters asked for first-class cannel. The only reasonable excuse for such a high price being charged was that foreign and continental gas companies were glad to get cannel at any price. I should like here to express an opinion, and one that I saw advocated in a public print not long ago, that we should impose a tax on exported coal. Seeing that coal is not "made in Germany," I think we could in all fairness do so. Various opinions have been expressed as to the resources and probable duration of the British coal-fields; and a time has been pointed to when these shall be exhausted. Be this period when it may, one thing is certain, that the increasing export of coal from this country will not stave off the evil day. When foreign nations compete with Britain in articles of manufacture, they ought to be compelled to pay for the material which enables them not only to do so, but to undersell us in our own markets. Probably this opinion may find its way to the Chancellor of the Exchequer, and induce him to relieve the British taxpayer of some of his burdens. Some of you may have read a description of a block of coal that has been hewn out of a pit in Wigan, and sent to the World's Fair at Chicago. This block of cannel coal weighs upwards of 12 tons. It took nine months to hew it; and it cost £83 per ton. Then it was boxed up, and sent by train to Liverpool for shipment; and it is not unlikely that this "black diamond," when it reaches its destination, will have cost more than £100 per ton.

Last year, Mr. Mackay [then of Peterhead] introduced to our notice the subject of enriching coal gas by paraffin oil or liquid hydrocarbons; and since then the question of making gas from oil has developed to a large extent. A process has been patented which removes any doubt that oil can be converted into a permanent gas, used as an enricher of ordinary gas, and thus form a mixture equal in every way to the gas obtained from the best cannel coal. I refer, of course, to the patent process of Messrs. Young and Bell, generally known as the "Peebles process." Much has been said and written about this process during the past six months; and many exhaustive reports have appeared in our technical journals, all of which, no doubt, most of you have read, more especially those of Mr. Mitchell and Mr. Linton, for the Edinburgh Gas Commissioners.*

* See *Journal of Gas Lighting*, Vol. LXI., pp. 738 and 795.

As we are to have papers on the subject from both the authors of the Peebles process to-day, it would be presumption on my part to say much about the subject. However, as President of this Association, and one of the deputation from the Research Committee who visited the Peebles works and saw the process in operation, I feel that it is a duty devolving upon me to express my opinion. While Mr. Mackay deserves every credit for introducing the question of the enrichment of gas by oil, there does not exist in my mind any doubt whatever that, if oil is to be used as an enricher, then the Peebles process is the one we should adopt. It is so simple, so scientific, that to see it is to stamp it with the hall-mark of a very practical and workable plant. No doubt the spraying and cracking up of the oil being operated upon in ordinary retorts by compression was a step in advance, and may be yet further developed. But, in my opinion, no amount of compressing, spraying, or cracking up can secure such results as have been obtained at Peebles by the *persistent* distillation of the oil in separate retorts, whereby all the oil is converted into permanent gas, and only free carbon, in the form of a rich coke and powerful heating agent, is left behind. This coke is almost pure carbon, and when burned leaves almost no ash. What could be more natural than to keep the oil vapour, as it leaves the retort, in contact with the oil as long as possible during the process, and then wash with the oil itself? This is just what we do with coal gas—condensing it in presence of its own oils and tars, and washing it in its own ammoniacal liquor. That Messrs. Young and Bell have made a great discovery, there can be no doubt. As someone naturally must be first, Mr. Scott, of Galashiels, has the honour of first trying this process on anything like a large scale. He has set twelve retorts, at a cost of £1100, to be used for oil distillation. These retorts, I understand, are heated by the spent heat from the ordinary coal retorts. I may say that the temperature required to gasify the oil is about 900° Fahr. I do not intend to describe the Peebles system; but I may say that the process of enriching must resolve itself into one of price. Already, as we all know, cannel coal can be bought at something like a reasonable figure; and every manager must consider for himself whether it is cheaper to use oil or cannel. There is a fascination about the oil process that will go a long way to ensure its adoption. Simply turn on an oil-tap, and the manufacture of gas commences and goes on. It is only necessary to remove the coke once a day.

As I have remarked, in every department of gas manufacture

progress can be noted; and the meter department is no exception. Mr. Keillor is to bring under our notice to-day the prepayment meter, which in my opinion is to be a boon, not only to gas consumers but to gas companies. We are all accustomed to the automatic supply system seen at our railway stations; and I think everyone must admit that to supply gas in this way is rather a startling announcement. That this meter is no toy, but a thorough practical piece of mechanism, may be gathered from the fact that in Liverpool alone nearly ten thousand of them are in use; and so popular are they with small cottage consumers, that gas companies have difficulty in supplying the demand. I have no doubt that Mr. Keillor, with his usual ability, will make out a good case for the prepayment meter. If any proof should be required of the growing popularity of the dry meter, the following figures should suffice: In the year 1862, 37,605 meters were tested in Edinburgh; of these 35,923 were wet and 1682 dry. In 1892, 38,608 meters were tested; of these 16,709 were wet and 21,899 dry. This needs no comment.

Mr. Ballantyne is to introduce the important subject of "Cooking by Gas." At no time in the history of gas lighting has the question of heating, cooking, and motive power by gas been brought so prominently before the public notice. Gas suppliers find now-a-days that means must be taken to push the sale of their commodity; and it is only by giving personal attention and advice to consumers who use these appliances that we secure success. In the first place, the supply of gas must be ample for the cooker or fire. Companies and corporations are seeing and recognizing the necessity of hiring out cookers at reasonable rates. Notwithstanding all this, in many towns the consumers are slow to adopt anything new; but once let them adopt cooking by gas, and by a little care and study master the simple manipulation of a gas cooker, and they rarely return to the primitive and wasteful common coal-fire. Anything we can do to increase the day consumption should have our double attention—seeing that the same plant is being made to do double service, and consequently the profit is increased. During the past ten years gas-engines have developed to a great degree; the engine itself has been perfected, not only for small motors but for sizes ranging up to 100-horse power. It has again and again been demonstrated that, to utilize to its fullest extent every atom of power in a pound of coal, the coal has to be gasified and the gas used to develop that power. And this is the sheet-anchor of gas managers.

The Yeadon retort, which Mr. D. M. Nelson is to describe to

us to-day, is the latest invention, having for its aim the automatic carbonization of coal. There are so many novel features presented to us in this invention, that at a first glance we are tempted to treat it as a toy. But those of you who, like myself, have carefully read the description of the invention given in our technical journals, also in the paper read by Mr. Terrace, of Middlesbrough, at the North of England meeting,* and the discussion that followed the reading of the paper, cannot fail to see, if they read between the lines, that all those who had seen the rotary retort actually at work were impressed with the idea that great things may be expected from this machine in the near future. We have a revolving tapered retort. The coal is treated in small quantities at a time, and is so thoroughly carbonized that surprising results are obtained. Fifteen thousand cubic feet of gas from a ton of small coal, and no coke—which in many gas-works is a great consideration—is something to think about. The small space this retort occupies, and the quantity of gas it is capable of producing in a year—about 30 million cubic feet—seems at first sight rather fabulous; and the probability of being able to supply a town of the size of the one I represent with one retort is rather astounding.

Among the subjects which have recently engaged the attention of gas engineers, automatic appliances to handle the coal and coke have held a prominent place; and complete self-acting plants are now in operation at a number of gas-works. At our meeting in Perth in 1890, we led the van by bringing this matter to the front with a paper by Mr. Gilbert Little, of the New Conveyor Company, of London and Aberdeen; and we are to have a paper to-day, from the same gentleman, on "Automatic Appliances for Small Works." Mr. Little's well-known picture of "An Automatic Gas-Works" adorns the wall of a large number of gas managers' offices; and the desire of a great many of us, as we look at the picture, is that the beautiful automatic scene depicted was a reality in our works. Complete automatic retort-houses are a reality at a number of large and medium-sized works; and Mr. Little will no doubt detail how similar self-acting plant can be arranged for small works. The idea of complete automatic gas-works has "caught on;" and as the appliances are now obtainable, we may confidently expect to see self-acting retort-houses the rule and not the exception.

I feel, gentlemen, that I have already taken up too much of

* See *ante*, p. 104.

the valuable time of the meeting; but this address would be incomplete did I not make some reference to our friendly rival electricity. That great developments in this system of lighting have taken place during the past fifteen years must be admitted; and that still greater developments will take place before another fifteen years pass over our heads, may be reasonably anticipated. It is 90 years since Davy first produced the electric light by the use of carbon points; but it was not till 1887 that it was first used as a means of light in many public buildings in London. Now, in 1893, there is hardly a town in any country that does not possess an electric installation. It is a singular fact that in no town where electric lighting has been introduced has the consumption of gas decreased. I would note the case of Eastbourne, as a striking example of this. Eleven years ago the electric light was introduced in the town; and since then the make of gas has increased cent. per cent. In my own town, there has been an increase in the face of three electric light installations; and I feel quite safe in predicting the same for Dundee.

I am sure that electricians owe a debt of gratitude to Mr. Denny Lane, for pointing out a means of overcoming the two greatest difficulties in the way, which prevent the electric light making such headway as it otherwise would; and at the same time gas companies must acknowledge their indebtedness to him for endorsing what we for some time have looked upon as a means of making an amicable union between gas and electricity. These two great difficulties, as he (Mr. Lane) points out, are, first, the cost and loss entailed in conducting the electric current from the station where it is generated to the consumer; and, secondly, the inability to store electricity. These difficulties are to be overcome by gas, converted into power by gas-engines, driving dynamos which produce electric current.* In Dundee there is a private installation of electricity, of over a hundred lights, the dynamo being driven by a gas-engine. The proprietors say that good results, both as regards efficiency and economy, are obtained; and they claim that the cost of the light is much less than that supplied by the Commissioners—viz., 3¼d. per Board of Trade unit, as against 5d. which is the Commissioners' price. A private installation of sixty 16-candle lights has just been introduced at Montrose. The dynamo in this case is also driven by a 7-horse power gas-engine, and the light is really at times very pretty. But, like a

* See Inaugural Address to The Gas Institute at Belfast, *Journal of Gas Lighting*, Vol. LXI., p. 1086.

bad supply of gas, it is very unsteady occasionally, and frequently disappears altogether; so that gas is being laid on, in order to light up the premises when the electric current refuses to be tempted along the wires. The novelty of the light carries it a long way. It is still a luxury; and as gas managers, we may have less fear to-day of its ever superseding gas than we had five years ago. If corporations in lighting their streets would spend on gas two-thirds of the money they devote to electricity, the latter illuminant would not be in the running. Electricity has been called the poor man's friend; but this must be a joke. In every installation the expense seems the greatest difficulty, both with the suppliers and the users of the light.

Water power has been suggested as a means of economy; but the power of water is often over-estimated. As an example, a large track of ground at Montrose called the "Basin," about eight miles round, is at each tide covered by water; and consequently the current of the flowing and receding tide through the bridge is very great. The City Fathers have had the idea of using this power for lighting the town. Only a few weeks ago a specialist was called in to feel the pulse of this mighty force; but, alas! it was found too weak to be of any use, and gas-engines were pointed to as the most economical means of producing the coveted current. The same mistake, we are told, was made in estimating the swift current through the London bridges.

I cannot do better than close this address by quoting the words of a former President, uttered fifteen years ago on this subject. After all these years, they are equally applicable to-day. He said: "We have heard of late much about electric light, and many fears have been expressed as to the probability of its superseding the use of gas; and I believe it has been the means of checking the anxiety of corporations to possess the mines of wealth supposed to belong to gas companies. Certainly science has done much of late for this new means of lighting; but it yet has much to do ere we will see the electric lamps at our hearths. By developing the use of gas for heating and cooking, our concerns will still be as successful and profitable, if not more so. It will take many years to weaken the hold gas has got as a necessity of life at the present day."

And now, gentlemen, I have finished. I have to thank you for the patient hearing you have given me; and to apologize for taking up so much of your time.

Mr. A. MacPherson (Kirkcaldy) proposed a vote of thanks

to the President for his most instructive address. The President had, he said, gone over a wide field, and touched on a great variety of points; and he was sure that, on studying the address at their leisure, they would profit very much by it.

Mr. A. YUILL (Alloa) seconded the proposal; and it was agreed to.

PAPERS AND DISCUSSIONS.

The reading of papers was then proceeded with.

Mr. G. KEILLOR (Nairn) read the first paper, entitled—

NOTES ON THE PREPAYMENT METER.

As requested, I have prepared a few notes on the prepayment meter system, with the view of bringing the subject before you for discussion. But having had these meters in use for only about a year, I am afraid my short experience may be of little service, and so perhaps part of the valuable time at your disposal may be taken up unnecessarily. However, I beg to ask your kind forbearance for a few minutes.

This prepayment adaptation to the ordinary meter may be said with truth to be another step in the right direction. The system has already been rewarded with very great success; and it is rapidly finding favour among the poorer class of gas consumers. By this arrangement, "a long-felt want" has been supplied. It is indeed a friend to the poor, and completely eclipses the old, but true, saying "Short accounts mak lang friends."

I may here state that, at a meeting of my Directors held in March, 1892, I had a meter fitted up in the Secretary's office, by which it was shown how a pennyworth of gas could be bought and afterwards consumed. The Chairman expressed great satisfaction with the arrangement; and said he considered the coin meter to be the best invention he had yet seen for the poorer class of consumers, and to keep gas companies from making bad debts.

A short time after this, twelve of these meters were ordered, so that I might experiment with them. These have now been thoroughly tested; and I am pleased to inform you the results were very satisfactory, and also that my anticipations formed with regard to the quantity of gas consumed, and the corresponding pennies in cash-boxes, have been more than realized. I may, however, state that I had very grave doubts as to the meters possibly being troublesome to consumers, by the light going out at a busy moment, or that the slot arrangement might

get out of order, and so pass a greater quantity of gas to the consumer than the money value in the cash-box. But in practice I find these apparent doubts and inconveniences entirely disappear. The consumer gets so well acquainted with the working of the meter, and the time his one, two, three, or more pennies' worth will last, that he likes the system, and is put to no inconvenience whatever. On one occasion only we had to take in a meter which ceased to give light; the cause of which was found to be a penny stuck in the slot—the penny having been by some youth hammered into an irregular shape —which necessitated our taking the cover of the meter off. Makers should therefore enlarge the slot a little, as it is not necessary for it to be the exact size to admit the coin.

When ordering these twelve meters, it was not my intention at first to press for new consumers; and, of course, we had no applications for them. But it occurred to me that, rather than give them to new consumers to commence with, I might select twelve ordinary small consumers, who were all more or less in arrear, and consequently would have been more than likely to have their gas supply cut off. Rather than do this, and very probably lose all, I used some liberty with these defaulters, by way of making an experiment with the prepayment meter. Most of them were glad to get such a meter; while several others absolutely refused to allow their meters to be shifted, and declared, if such were done, they would commence using oil. Notwithstanding these remonstrances, I insisted on having the meters put in; and, strange to say, on making our periodical calls three months after, we did not find oil in use, neither did we find the cash-boxes of the meters by any means empty. On the contrary, nearly double the quantity of gas had been paid for than would have been consumed by the ordinary meter; and this without a word of complaint. One consumer remarked: "I doubt you have given me a stick to break your own back with. You will not get me overcharged this time, as you did the three corresponding months last year. I have only put in a few pennies each time I needed light; and that was no oftener than I could help." However, on reading the meter, the inspector considered that, if the pennies in the box agreed with the number of feet registered, the gas company would have no reason to complain; and the consumer also was apparently well satisfied. The result was 12s. in the box, as compared with 7s. 6d. the corresponding months complained of.

To show how accurately the arrangement works out, compared

with the ordinary index-reading, I have noted down the results of the first two quarters. From Nov. 1 to Feb. 1, the twelve meters indicated a total consumption of 13,200 feet. This, at the rate of 10 feet a penny, or 8s. 4d. per 1000 feet, makes a sum of £5 10s. value registered; while the money taken from the meter cash-boxes was £5 10s. 5d.—being 5d. more cash than the number of feet registered amounted to. This extra 5d. was accounted for as having passed through the slot, to pay for gas not yet consumed. The average per consumer was thus 9s. 2d.; and this with consumers of one burner each. Again, the same twelve meters for the quarter from Feb. 1 to May 15, indicated a total consumption of 11,200 feet, being £4 13s. 4d.; while the cash in the meter boxes was £4 13s. 11d. This time, therefore, there was 7d. more than the amount charged for the gas consumed.

Our ordinary price is 6s. 8d. per 1000 feet for lighting, and 4s. 2d. for heating and cooking, &c.; but to cover the extra cost of the meter and meter-rent, we set our prepayment meters at 10 feet a penny—being 8s. 4d. per 1000 cubic feet, or 1s. 8d. above the ordinary price. The makers sent out some time ago a circular-letter in which they say, regarding their prepayment meters: "Gas so supplied is generally sold at a slightly higher price than is charged for it through the ordinary meter, so as to cover interest and other charges; but this is a small matter compared with the advantage to the consumer. The increased rate should include meter-rental, to obviate extra charges, which are unpopular with the consumer, who has, in this case, only to place a penny in the slot, and procure a certain quantity of gas." I have merely given these few details to show how accurately the measuring of a pennyworth of gas at a time compares with the index-reading at the end of three months. Also that there is an increase of gas consumed, to the extent of about 33 per cent. over the ordinary meter, and that these consumers are much more satisfied.

I have now only to say that gas companies and corporations ought to give notice, by advertising or otherwise, to all proprietors, architects, and builders, that, when erecting new buildings or when altering old ones, the gas company will supply automatic meters to be fitted into all workmen's houses. Also that, when architects specify the plumbing and gas-fitting work, it should be specially mentioned in the specification, to the effect that a meter and suitable gas-bracket will be fitted up complete, by the gas-fitter, after which the gas company will send an official to instruct the tenants as to the working

of these prepayment meters. In Nairn, among other buildings, I did the architectural work in connection with a block of houses where there are twelve tenants. In the specification of plumbing and gas-fitting work, it was specified that one automatic meter must be fitted complete into each house—the meter to be supplied by the gas company, and fitted in by the contractor. I know very well that none of these twelve tenants had any intention of using gas when they rented these houses—most of them, in fact, informed me they did not want the meter placed. But, on discussing the matter with them, I said it was part of the gas-fitter's duty to fix these meters; and that they had better allow the meter to be put in in the ordinary way. I also took the opportunity of saying that perhaps the first time they were out of oil, or it may be a lamp chimney got broken, they might for a change put the value of the new lamp chimney in the slot of the meter; and by so doing they would come to see how handy and ready the gas is when obtained in this way, compared with oil. I remarked that ultimately I expected to see an ornament on each of their shelves, in the shape of an oil-lamp.

Well, whether or not you believe the system to be just as successful as I do—a great deal of which success depends on gas managers themselves—there is one thing certain, that the cleanliness, readiness, and easy purchase of the light by this system will go on finding favour among the poorer classes; and I most certainly recommend the system wherever gas is used. And, further (more especially in small towns), I would say should this class of consumer not get the opportunity to use gas by this system, we shall be guilty of what I am afraid we too often are—viz., "standing in our own light."

Discussion.

Mr. W. A. Valon (Ramsgate) said he agreed with their friend who had read the paper that there was not the slightest doubt that they were moving in the direction of introducing more prepayment meters daily. Some companies had gone very largely into the question. He had himself worked on the same principle as the author of the paper, but not with the identical meter. In his opinion, it was better to put a stop on the index, for a certain amount of money in advance. He had used these "penny-in-the-slot" meters; but he did not think they gave him the satisfaction which their friend had described. He found, first of all, the instruments themselves were somewhat

expensive; and, besides this, they were liable to derangement. Of course, these were all things that might be overcome; and he had no doubt they would be. The President, in his address, mentioned a certain town where there were 10,000 of these meters employed. He did not know if it was the same town he referred to; but he knew a place where there were something over 7000, and he understood that they were so far unreliable that an agreement had to be made with the consumer that not the number of pennies in the box should be the indication of the quantity of gas consumed, but the index itself—it being found that every quarter about 15 per cent. of the meters were wrong. That was to say, that there had to be an adjustment of accounts in about 1000 out of 7000 cases. This was a serious drawback. Some had to pay more, by finding that the amount in the box did not agree with the index; and some had paid too much, and this had to be returned. But he thought there was another point which was equally important in connection with the prepayment meter (if he was not going outside the range of the paper), which was that, in cases where fittings did not exist in houses, it was all very well to ask builders and contractors to put pipes in—sometimes they would not, and sometimes they did; but he thought it was there that companies might come in and assist poor people to burn gas. It was not a very serious matter. It cost about £3 on an average for a house of £12 to £30 a year rental—that was to say, that for £3000 they could secure 1000 consumers. He did not believe there was any gas company who would not pay £3000 of invested capital to secure this number of consumers. He certainly must think, seeing that he took this meter in hand some years ago, that it was a step in the right direction. He did not know that it altogether depended upon meters of any class; but certainly shorter payments, arrangements with consumers to collect their accounts more frequently, the fitting up of houses, and the giving to that part of the public who had not hitherto been able to use gas the opportunity of burning it under easy conditions, were directions in which all companies and corporations ought to move.

Mr. J. HEPWORTH (Carlisle) was sorry his experience did not enable him to say anything of much value. He agreed with the author of the paper that they did stand in their own light whenever they failed to take the opportunity of furthering the consumption of gas. He happened to be Gas Engineer in a town where the consumption was very extensive—he meant where the number of consumers was greater than perhaps it was in

most other places in proportion to its population; and they never felt the necessity of adopting the prepayment system. But he quite believed in everything that had been said in its favour; and he should not be afraid of a possibility of error in 15 per cent. of the number of meters, because he took it that this was almost incidental to the initiation of the system. A very little time would doubtless put these meters right; and the experience that had been detailed in the paper read to them was in itself most encouraging in this respect.

Mr. D. Vass (Portobello) said he should like to relate one experiment he had made with a prepayment meter. The meter had been connected to a gas cooking-stove; and it had been found to be very serviceable in this respect—that there was a servant in the house, and the mistress could control the quantity of gas used in cooking by the number of pennies that she gave to the servant. There was one point in Mr. Keillor's paper he was not very sure about—the amount he added on, to cover meter-rent. He thought they should keep this limit as low as possible; and his reckoning was—he had only gone into it on a small scale—that they should count upon 3000 cubic feet per annum, and that their charge should be perhaps about 2s. for meter-rent. That for a year, covering 3000 cubic feet, would run to about 8d. per 1000 feet beyond the price of gas. There was one point about these appliances—viz., that they had them always fitted on to dry meters; and if the consumption was anything like irregular—if it were stopped, for instance, for a few months in the year—he should fear that there would be a stiffening of the diaphragm of the meter. He had asked if he could not be supplied with wet meters; but there seemed to be a difficulty in fitting the prepayment appliance on to such meters. He thought, if they had it upon a wet meter, there would be more confidence among gas managers in recommending it. He had no hesitation in saying that it worked very well as it was, except for the drawback he had mentioned. Then, again, he thought that it should only be applied to new consumers. They had perhaps a thousand consumers in a town; and if they were to be asked to put in prepayment meters to all these, what were they to do with the old meters, some of which might have been in use for only five or six years?

Mr. W. Cheyne (Briton Ferry) stated that he had had a little experience with these meters; and he could endorse every word Mr. Keillor had said. He had had them in use for about three years; and he found that people, while they put in double the quantity of what their bill used to come to, never said a

word about it. If they were to present a bill for (say) 5s., there would be grumbling; but consumers would put in 10s., and never make a single remark. So far as registering the quantity corresponding to the pennies put into the box was concerned, he had found no trouble at all with that. He once had a stop, but it was owing to a penny being bent; and after that he cautioned people always to put in perfect pennies. He might also say he found a two-shilling piece in one meter, which, of course, he returned. The way they managed was this: They charged a penny for 20 cubic feet; and as their price was 3s. 9d., this represented 5d. per 1000 feet towards the expense of the meter. They had the money at the end of the year; and if there was anything over and above paying the meter-rent, they returned it to the consumer. It ought to be done in this way, because there were no bad debts and no risks to be run; and he found that there were often a few pennies to be returned at the end of the year. In the case of cookers, he thought the prepayment system very suitable for persons who went away to the seaside for a time. They would sometimes have a great row with such people, who said they did not use the quantity of gas because they had been at the seaside most of the time. Well, he believed these meters were the right things; because, when the family went away, they had only to put so many pence into the box, and then if the housekeeper were extravagant she must find the money for the gas out of her own pocket.

Mr. A. MacPherson (Kirkcaldy) said he could not add anything to the discussion, having had no experience of prepayment meters; but he had no doubt that they would very soon take their place in gas-works. It was quite evident that by this system they would be able to save a considerable amount of bad debts; and there was no doubt there was a grievance against cookers on account of the waste that servants were guilty of, which could be obviated by the fixing of a prepayment meter. If they were able to say to a lady, when they gave her a cooker that she could regulate her daily supply by this means, they would have more of them disposed of. He must say that he highly commended Mr. Cheyne's honesty in returning the few coppers that were over at the end of the year; and if all consumers were treated in that way, they would very soon become friendly to prepayment meters. It certainly said a good deal for Mr. Keillor, that he had been almost the first in Scotland to introduce these meters.

Mr. R. Cowie (Tillicoultry) said he was very pleased to hear the paper read by Mr. Keillor, and was prepared to endorse

everything he had heard regarding it. He had had some little experience with prepayment meters, having fixed about eleven of them for new consumers—that was, people who had never burned gas during his sojourn in the place where he was—and they had given the utmost satisfaction. With regard to the gas consumed and the money tallying with it, he had had no difficulty whatever. He might say that a party once applied to him for gas who was improvident in her habits; and he showed her what the cost would be with an automatic meter. She said she would be very pleased to have it; and he therefore had one fixed up. The first quarter he had 90d.; and the second quarter—from November to February—13s. She was quite delighted with the meter, and stated that she would not part with it on any account. He had had some fixed in a house occupied by single women working in factories, who had had gas-grills supplied to them. They never used a penny-worth of gas for lighting, as they burned paraffin; but they cooked with gas, and they said they would not do without it under any circumstances. He had been deluged with applications for automatic meters. He had over a hundred applications by people already burning gas; but he demurred to supplying the meters to present consumers.

Mr. W. CHALMERS (Alva) remarked that he had had some experience with prepayment meters, and they had given satisfaction. The money and the registers tallied; and he never had had any trouble with the meters stopping.

Mr. J. M'CRAE (Dundee) said there was one point which had not been brought out, although he had been waiting for it. It had always appeared to him to be a great hardship upon poor consumers of gas that they should have to lodge a deposit. In Dundee, people could not get a supply of gas unless they paid a deposit or had a guarantee. It was a most difficult matter to find in a strange town anybody who would be security for them; and it was also a great hardship to pay 5s. or 10s. down before they could obtain a supply of gas. But the "penny-in-the-slot" would get them a supply; and they could pay for it as they went. These meters would be a great convenience to such people.

The PRESIDENT thought they had had a very happy discussion upon the paper. He had one or two prepayment meters in use; and there could be no doubt that these appliances were destined to supply a want in the business of selling gas. There was no doubt about it; and it would be a great boon to the honest poor. Some poor people, if they could get a meter, would burn away at the gas without caring whether or not they could pay for it;

but they had honest poor, who were frightened to burn gas for (say) three months without paying for it. Gas was not like any other commodity. They consumed it, and they had the light; and it was then past and gone before they had to pay for it. Mr. West had just informed him that in London these meters had taken a tremendous hold, and that the London Gas Companies had given manufacturers orders to send in as many as they could possibly make. He did not believe there could be any difficulty about producing a reliable meter, either dry or wet; and he should think it ought to be very easy to adapt the stopping principle to a wet meter. They knew that some wet meters were not very difficult to stop without automatic appliances; and, in his opinion, it was only a question for the manufacturers whether they would make these meters wet or dry. He fancied, however, that wet prepayment meters were made at present. He was very pleased that they had had such a good discussion, because he was himself responsible for the reading of the paper; and he could assure them that he had very great difficulty indeed in persuading the author to come forward with his few notes. It must, therefore, be very gratifying to Mr. Keillor that his communication had raised such an interesting discussion. Mr. Valon, he thought, was the one exception; he was the only gentleman who had given them his experience as to the questionable reliability of these meters. He (the President) did not see how they could fail, seeing that they had always the ordinary index of the meter to fall back upon. If the consumer were really honest, and they found that there were not enough pennies in the box to recoup them for the quantity of gas indicated on the ordinary index, he thought they would not have much difficulty in persuading him to pay the difference.

Mr. KEILLOR, in replying, said that the only thing he had to refer to was that, so far as the merit of the meter was concerned, he would not like his price to be taken at all, because he lived pretty far north. He put on 1s. 8d. simply so as to keep himself right in an experiment; but he thought 8d. or 10d. per 1000 cubic feet would be a sufficient charge for meter-rent.

Mr. W. YOUNG (Peebles) then read the following paper:—

THE PRINCIPLES OF THE PRODUCTION OF ILLUMINATING GAS FROM LIQUID HYDROCARBONS.

Owing to the enormous supplies of high-quality natural petroleum oils, our native industry of artificially producing mineral oil from shale by destructive distillation has lately

suffered severely, more particularly in respect to that part of the distillate of the paraffin oil having a high specific gravity which was manufactured into lubricating oils; and especially where the shales necessarily produced oils of low viscosity. So much was this the case that in several works they were almost unmarketable, and were used as fuel under the steam-boilers. Many attempts had been made to employ these oils of high gravity for the production of illuminating gas; but, owing to the high percentage of carbon in their constitution, they gave so much trouble from sooty, pitchy deposits in the gas-producing apparatus, that they could not be economically used by existing commercial processes. At the instigation of Mr. John Fyfe, of Young's Paraffin Light and Mineral Oil Company, I, with the assistance of Mr. Bell, made a series of experiments with the view of discovering some method of manufacturing illuminating gas from such heavy oils, without the accompanying inconveniences. Mr. Bell is to read to you to-day a paper upon the process, which has been the practical outcome of these experiments; and I thought I might usefully premise his paper by a few remarks upon the principles relating to the production of gas from oil, more particularly those which guided us in our experimental work.

I have on several previous occasions given to this and the Association now merged in it my views and the results of experiments relating to the principles of the production of illuminating gas, more particularly from coal and shale. They also, however, apply to and embody most of the principles which have formed the basis of our experiments in producing illuminating gas from heavy hydrocarbon fluids. I will therefore refer you back to these prior communications for details—dealing in my present paper only with broad principles, and taking them in the following order:

(1) The manner in which heat acts upon hydrocarbon vapours in bringing about their decomposition into gaseous compounds.

(2) The conditions modifying the decomposing action of heat: (*a*) Temperature of heat; (*b*) time occupied in effecting decomposition; and (*c*) the atmosphere in which decomposition is effected.

(3) Constitution of the resulting compound due to these various causes, in relation to the greatest illuminating power obtainable in the form of gaseous compounds from a given quantity of hydrocarbon fluid.

At a meeting of the West of Scotland Association of Ga

Managers held at Kilmarnock in September, 1878, and again at a meeting of this Association held at Perth in July, 1880, special reference was made to the manner in which heat acted upon hydrocarbon vapours.* The theory then advanced was that it acted in two ways—first, by direct contact between the molecules of the hydrocarbon vapours and the heated surfaces in the retort, and secondly, as rádiant heat upon the molecules of the hydrocarbon vapour in the free space over the coal; that there was an essential difference in the products from a given hydrocarbon, dependent upon whether or not the decomposition was effected by heat communicated by contact, or by heat in the radiant form; that surface-contact led to an indiscriminate shattering of the hydrocarbon vapours, or at least to the production of a different class of compounds from those which were produced by the action of radiant heat; that radiant heat did not act upon a complex mixture of hydrocarbon vapours indiscriminately, but that the waves of heat from the walls of the retort were selective—passing freely through the elementary gases and simple vapours, but acting more and more vigorously upon the molecules of the hydrocarbon the higher their complex structure, leading to their decomposition into simpler bodies.

Practical experience in many operations bears evidence that there is some truth in the theory. For instance, the effect of surface-contact in bringing about an indiscriminate shattering of hydrocarbon vapours was well illustrated in the Malam process, and also in the case of one of my early attempts, along with the late Mr. Scott, of Musselburgh, to improve the system of carbonizing coal. By both arrangements, the volatile hydrocarbonaceous vapours and gases coming from the coal were passed through a mass of incandescent coke, with the like results—the shattering up of the hydrocarbon vapours into a large volume of almost non-luminous gases and a quantity of sooty pitch, which gave an endless amount of trouble from the choking up of the apparatus. These two processes were repeats, in principle, of a legion of similar ones which had gone before, including those oil-gas processes where the decomposition of oil was brought about by red-hot surfaces in the production of gas. They all failed from a like cause. The action of radiant heat upon hydrocarbon vapour in a free space is illustrated when retorts are worked with light charges, leaving a considerable empty space over the coal. There is little doubt the superior results obtained under such circumstances

* See *Journal of Gas Lighting*, Vol. XXXII., p. 715; and Vol. XXXVI., p. 299

are, to a very considerable extent, due to the selective action of radiant heat acting upon the complex hydrocarbon molecules decomposing them, and leaving the simpler hydrocarbons unaffected; and I have no doubt that the same remarks apply to what is known as the Dinsmore process, where the hydrocarbon products from a series of retorts are made to pass through what is called an empty duct, and that any improved result obtained is due to a like cause. In short, out of the very large number of systems of carbonizing coal or oil for the production of illuminating gas, none of them have proved successful that had not a vacant space in which radiant heat could act upon the hydrocarbon vapours.

In the early days of the shale oil industry, horizontal retorts, in which there was a considerable empty space left, were employed for the destructive distillation of shale. The resulting oil was small in quantity, had a low specific gravity, contained a large percentage of hydrocarbon, having a low boiling-point and a small quantity of the solid paraffins; and there was produced a large volume of illuminating gas. All these results point to the effects of radiant heat upon the hydrocarbon vapours in the empty space over the shale in the retort. When vertical retorts came to be used, in which the shale completely filled the retort, the resulting oil was larger in quantity, higher in specific gravity, contained a considerably larger percentage of the solid paraffins, and less of the oil having a low boiling-point; and the make of gas was considerably less—all pointing to a smaller decomposition of the hydrocarbon vapours from the shale. The object of the shale oil distiller is to conserve the hydrocarbonaceous constituents of the shale in the liquid form; and he has abandoned every shape of retort that had a free space in which radiant heat could act upon the hydrocarbon vapours.

Even in the subsequent distillation of the oils in the process of refining, it was observed that a large amount of decomposition took place, that there was produced a considerable volume of permanent gas, and that the greater the free space in the still over the oil, the greater was the destructive decomposition. When the process of distilling the oil was made continuous—running the oils into the still at the same rate that they distilled out, keeping a very small free space over the oil in the still—the decomposition was reduced to a minimum. On the other hand, the decomposing action of radiant heat in the vacant space in the still was utilized in cracking up some of the heavier oils which had a low market value into lighter oils of greater

value. To accomplish this object, large stills were employed, and only the bottom of the still exposed to the fire was covered with the low-priced oil to be decomposed; and the temperature applied was just sufficient to slowly volatilize the oil into the vacant space, where the vapours exposed to the radiant heat were gradually decomposed into more volatile oils, which passed from the still to the condenser. In some cases a fractionating arrangement was placed between the still and the condenser, by which the portion not sufficiently cracked up was continuously returned to the still, to undergo further decomposition.

The decomposing action of heat upon a hydrocarbon vapour may be considerably modified by a number of conditions. For example, the temperature of the heat; the time for which the hydrocarbon is exposed to the decomposing action of that heat; and, in the case of some of the processes by which illuminating gas is produced from hydrocarbon fluid, the atmosphere in which the decomposition is effected. The factors of time and temperature are well illustrated in the process of cracking up the heavy hydrocarbons into lighter ones, to which I have just alluded. We there saw radiant heat of any low temperature applied for a long time bringing about the cracking up of the complex molecules of the heavier oils into the simpler molecules of lighter oils suitable for the manufacture of lamp oils. The same result could not be obtained by a shorter exposure of the vapours of the heavier hydrocarbons to a higher temperature. The heat of higher temperatures applied for a shorter period of time in a shallow free space would produce a different class of products altogether. The action of heat under the two conditions may be likened to that of the use of gunpowder and dynamite in blasting rock. The comparatively slow explosion of gunpowder would simply tear the rock into large masses suitable for building purposes, whereas dynamite, on the other hand, would shatter the rock into useless fragments. If, during the process of cracking the heavy oils, the conditions were modified by admitting an atmosphere of dry steam into the free space in the still among the hydrocarbon vapours, the cracking up of the vapours would cease, because the molecules of steam would take up a part of the molecular motion of the hydrocarbon vapour imparted to it by the radiant heat, and prevent it, so to speak, from being shaken to pieces to form the simple molecules of lighter oils. Steam, under such conditions, has a protective action. If, however, on the other hand, the mixed water and hydrocarbon vapour were exposed for a short period of time to heat of a temperature

sufficiently high to decompose the water vapour in the presence of the hydrocarbon vapour, then mutual decomposition would take place; the oxygen of the water vapour going to the hydrocarbons, setting free hydrogen, and producing hydrocarbon gases and vapours and carbonic acid or carbonic oxide in varying quantities, dependent upon the temperature that is employed.

Various processes for the production of illuminating gas from hydrocarbon fluids, based upon the reaction between steam and a hydrocarbon vapour, have been tried; the desired object being the utilization of the surplus carbon present in all, and particularly in heavy oils, to produce water gas to dilute the rich hydrocarbon gas. Had it proved possible to confine the action between the steam and the hydrocarbon vapour to the purely surplus carbon, the process would have been an ideal one. Unfortunately, however, at the instant of mutual decomposition, the oxygen of the steam does not confine its operation to the surplus carbon, but goes direct at the hydrocarbon; bringing about the destruction of a large quantity of illuminating matter. Besides, the carbonic oxide produced has a destructive effect upon the illuminating constituents present in the gas, probably due to the combustion of the carbonic oxide taking place simultaneously with that of the illuminating gases, or even to the carbonic oxide remaining unconsumed until the hydrocarbon has been partially decomposed, and only being consumed in the upper part of the flame, and thus acting on its illuminating portion as an inert gas. These remarks also apply, more or less, to the production of illuminating gas, by injecting or commingling a hydrocarbon fluid with coal during the process of carbonizing. Undoubtedly the large volume of hydrogen and marsh gas present has the effect of, to some extent, protecting from over-decomposing the hydrocarbon vapour. The water vapour, however, which is more or less present, leads, by its interaction with the hydrocarbon vapour, to considerable loss in illuminating power. There is also little doubt that the very large heating surface and the comparatively small free space tend to lower the total illuminating value obtained from a given quantity of hydrocarbon fluid.

When shale is carbonized direct for the production of gas, the volatile hydrocarbonaceous products are decomposed in the presence of the water vapour simultaneously eliminated from the shale. The largest illuminating power obtainable under such conditions will not exceed 40 candles. If the same shale is distilled at a temperature sufficiently low to prevent to a large

extent the interaction between the water and the hydrocarbon vapour, so as to produce mineral oils, and if these oils are isolated from the water, and subjected to decomposition, gas having an illuminating value twice as great as that realized from the direct carbonizing of the shale is easily obtained—showing the great deteriorating effect there is in the presence of water vapour during the decomposition of a hydrocarbon vapour into illuminating gas.

On the other hand, in those classes of processes where illuminating gas is produced by decomposing hydrocarbon vapour in an atmosphere of water gas, heat of a high temperature can be employed to do the work of decomposition, as the effects of the heat are very much modified by the molecules of the inert gas taking up part of the motion communicated to the hydrocarbon vapour by the radiant heat, and by acting as a cushion in preventing the shattering action of heated surfaces. It, however, requires careful adjustment between the temperature of the heat and the volume of vapour in relation to the volume of inert water gas, to bring about just that amount of decomposition of the hydrocarbon vapour that is desirable; and this difficulty is accentuated in those processes (such as the Lowe) where the operation of producing gas is intermittent, and where the surface to decompose the hydrocarbon is heated by the producer gas from the water-gas cupola. At the commencement of the gas-producing period, when the surfaces are highly heated, there is a tendency to over-decomposition, with the production of soot; and before the end of the period, a considerable quantity of the hydrocarbon vapours is not sufficiently decomposed, so that only for a period in the middle of the run are the conditions suitable for the purpose aimed at. There is, besides, the difficulty, of condensing the very large volume of gas, and separating from it the condensed hydrocarbons, which are in so finely divided a state that they keep floating forward long distances in the current of gas.

These defects are to some extent compensated by the simplicity of the process; the large volume of gas that can be produced on a given space in a given time; and also by the fact that the water gas takes up and holds in diffusion volatile hydrocarbons that would otherwise assume the liquid form. And if the process discovered by Professor Lewes, for the production of illuminating gas by simultaneously decomposing hydrocarbon liquids and producing pure hydrogen from steam by means of metallic iron, proves as successful as the results obtained at Aldershot would indicate, those objections would be

still further removed.* Improved results would also be obtained by applying the principles embodied in the Peebles process to that class of processes. Owing, however, to the deteriorating effect of carbonic oxide (due probably to the causes to which I have already referred), the same value in the form of a purely enriching agent will not probably be obtained by any combined hydrocarbon water-gas process as can be secured from the oil decomposed by itself. Besides, from what I have already stated, it will be evident to you that the decomposition of hydrocarbon fluids is far more under control when they are decomposed by themselves.

I have, in my previous papers, on several occasions spoken of the advantages of fractional decomposition and fractional condensation; and I have again to ask you to note the advantages of the application of those principles in the decomposition of such hydrocarbon fluids as are at our disposal. The hydrocarbon fluids—especially such as are used in the production of gas—are never homogeneous. Those at our control are the various grades of natural and artificial mineral oils or tars, which are all mixtures of various hydrocarbons, and all of which probably require heats of different temperatures to economically convert them into permanent gaseous compounds. Under such conditions, it is very probable that the best results will be obtained by subjecting each hydrocarbon to the temperature appropriate to its gasification with the least amount of deposited carbon; and even allowing the hydrocarbon to be homogeneous—say, a higher member of the paraffin series—in order to decompose it into gaseous compounds with the least loss, it would require to be cracked up in successive stages. In order to accomplish this object, it is necessary that it should undergo a succession of decompositions by which part would be gasified; thereafter cooling the resulting products so that the condensable matter may be again returned to the retort, to be subjected to decomposition for further gasification—the alternate process being repeated till the whole hydrocarbon was resolved into the highest quality of permanent gas, with the smallest deposit of solid carbon. This fractional method of decomposing the hydrocarbon fluid has the further advantage that the quantity of carbon set free at each operation is small; and the large quantity of liquid accompanying the gasified portion washes any solid carbon back into the retort, and leaves it

* Illustrated descriptions of the process here referred to will be found in the *Journal of Gas Lighting*, Vol. LXI., pp. 644, 890.

there in a compact form. Thus one of the greatest difficulties experienced in the decomposition of liquid hydrocarbons containing a large excess of carbon in their constitution, is completely overcome, enabling crude tars and tar oil to be as easily converted into illuminating gas as the most refined volatile hydrocarbons.

This now brings us to consider what are the best class of hydrocarbons to aim at producing, so as to obtain the greatest possible illuminating matter in the gaseous form from a given hydrocarbon. There is no doubt that the constitution of the liquid hydrocarbon employed will have a considerable influence upon that factor in the problem. Commencing with a series of comparatively saturated hydrocarbons, the decomposition can be regulated stage by stage to that desired. It is very different, however, starting with a complex hydrocarbon like coal tar or tar oils, containing various groups of hydrocarbons, which have already been so altered by heat that the process of converting them into the gaseous form necessarily involves, in the operation of cracking, the setting free of a large part of them in the elementary condition of hydrogen and carbon. It has also been considered whether the resulting products of decomposition are to be rendered permanently gaseous by themselves, or whether the resulting gases are to consist of partially gasified hydrocarbons held in diffusion through water gas. At a meeting of this Association held in Edinburgh in July, 1879, I read a paper on the proportion of carbon present in a gas in relation to its illuminating power, which directly bears upon this subject.* Attention was then drawn to the relative illuminating power of carbon, combined with hydrogen in the form of paraffins, olefines, and the aromatic group of hydrocarbons. It was then shown that, by the splitting up of a paraffin into an olefine and free hydrogen, the illuminating power was largely increased; and in the same way, the illuminating power of the same paraffin, when split up into benzole and free hydrogen, still further increased. But it also shows that the benzol could not be kept in the state of diffusion at ordinary temperatures, by the quantity of hydrogen set free in the splitting-up process, assuming in all cases no carbon was set free.

Now, the tendency of radiant heat is to split up a complex paraffin into a simpler paraffin, and olefines; and this process of splitting up goes on till the paraffin is cracked into a series of

* See *Journal of Gas Lighting*, Vol. XXXIV., p. 220.

olefines and the lowest members of the paraffin group CH_4, which is a very stable compound. On the other hand, we have observed that heat communicated by surface-contact to a paraffin has a tendency to produce hydrocarbons of the benzol group. These observations would indicate that, when the hydrocarbon gas has to be used alone, or as an enriching agent to increase the illuminating power of a coal gas, whatever the constitution of the hydrocarbon, the decomposition by radiant heat in free space with a limited amount of surface would be the best method; and that, on the other hand, when the hydrocarbon vapours are decomposed in an atmosphere of water gas, and where time and available space have to be considered, and where the resulting products of decomposition are to be held in diffusion by water gas, under such conditions surface decomposition may be more freely employed. With heavy hydrocarbon fluids, however, which deposit a large quantity of solid carbon during decomposition, surface-contact cannot be economically employed.

Among my earliest communications to the West of Scotland Association was an unfinished paper left in my hands on the death of my brother-in-law, Mr. Cusiter, of the Dalkeith Gas-Works, who, a short time before his death, had been appointed one of the Committee to investigate into the matter of obtaining a substitute for water in wet meters. Amongst the materials tried was intermediate paraffin oil; and he was surprised to find that the oil reduced the illuminating power of the gas to a large extent. Investigation showed that the result was due to the absorption of the volatile hydrocarbon liquids diffused through the gas by the oil. I have no doubt many of you will remember some of the papers I have communicated on the subject, showing how that observed fact of the solvent affinity of oil for hydrocarbons was turned to the practical purpose of recovering the hydrocarbons from waste gases in the distillation of shale, and also how it suggested improved systems of condensing our coal gas, by which the solvent affinity of the heavy tars was avoided, and a greater quantity of hydrocarbon vapours left diffused through the gas, thereby increasing its illuminating power. That same observed fact is now being applied to, and forms one of, the principles of producing illuminating gas from mineral oils. As you are aware, illuminating gas produced from mineral oil, owing to the presence of any large volumes of volatile hydrocarbons present in the product of decomposition, is liable to be supersaturated with those volatile products, and such gases are apt to deposit their

surplus hydrocarbons under the conditions to which they are exposed during distribution. The principles of fractional condensation, in conjunction with the solvent affinity of the oil, when properly carried into effect, completely overcome these difficulties; and a permanently gaseous compound can be obtained which will resist all climatic and other changes.

There are other points of interest in connection with the principles of the production of illuminating gas from oil; but the time allowed prevents me saying more on the subject to you on the present occasion.

Mr. A. Bell, jun. (Peebles), next read the following paper:—

THE PRODUCTION OF ILLUMINATING GAS FROM LIQUID HYDROCARBONS BY THE PEEBLES PROCESS.

In the instructive paper to which the members have just listened, Mr. Young has communicated to them the principles of the decomposition of liquid hydrocarbons in the production of illuminating gas, and in particular those principles on which the Peebles oil-gas process is based. It therefore only remains for me to explain the manner in which these principles have been carried into effect, and to give the results obtained from the practical working of the process.

Before proceeding, however, to describe the accompanying diagram, I may state that, in the experimental operations conducted at Peebles, vertical, horizontal, and inclined retorts were all used, also various forms of condensing and washing arrangements, each of which was found to be equally well adapted for carrying out the process. Of course, in practical working, the form and arrangement of the apparatus will depend to a great extent on the conformation of the works into which it is to be introduced, and the purpose for which it is to be used. Where, for instance, it is desired to economize space, the retorts may be vertical, instead of horizontal; and so with the condenser, which moreover may be combined with the scrubber to form one piece of apparatus.

But perhaps the simplest of all arrangements is that shown on the diagram, which, with a slight modification, is actually the plant in operation at the Galashiels Gas Company's works. A glance at the diagram will show that the apparatus employed is very similar to that used for the ordinary manufacture of coal gas. The only differences, indeed, so far as the plant is concerned, are that the retorts are much larger than those used in the case of coal gas, that they are made of cast iron instead of fire-clay, and that they are provided with

valves and pipes for the admission of the oil; while, with regard to the arrangement of the apparatus, it differs merely in this, that each part in succession is placed above the other, in order that the fresh oil introduced at the top of the scrubber, together with the condensed products, may flow continually downwards until they reach the retorts. When we bear in mind what Mr. Young has said respecting the action of heat on hydrocarbon vapours, when it is communicated to them by direct contact on the one hand and by radiation on the other, it is evident that, in order to produce gas economically from oil such as is being used at Galashiels, the retort must be of such a form as to give the greatest amount of internal space with the least amount of surface. Now, the only convenient form of retort that approaches to this condition is that of a cylinder; for the surface of a cylinder is directly proportional to its diameter, while its capacity is proportional to the square of its diameter. From this, it also follows that the greater the diameter of the retort, the smaller will be the surface exposed compared with the internal space. Besides, it is obvious that a retort of cylindrical form offers certain advantages—being easier made, and being readily turned in its place should it become bulged or cracked by the action of the heat. Accordingly, the retorts shown on the diagram are cylindrical in form, and are as large as the size of the ovens would admit. They are 27 inches in internal diameter and 9 feet long; and, as you will observe, they are laid with a downward inclination equal to about half their diameter. You will further notice that they are placed back to back with an ordinary setting of coal-gas retorts, the products of combustion from the semi-producer of which, after heating the coal-gas retorts, are employed to heat the iron retorts, being quite sufficient to maintain the low temperature necessary for the decomposition of the oil. Attached to the front of each oil retort is a mouthpiece, provided with a circular door and an off-take pipe. The latter is joined to the hydraulic main in the usual manner, by means of ascension, horizontal, and dip pipes. From the end of the hydraulic main, the horizontal condenser is carried with a slight inclination upwards, until it joins the bottom of the scrubber. The scrubber, which is one of the type originally designed by Mr. Young, and with which most of the members are acquainted, contains four trays, each of which is provided with the usual tubular openings and inverted tin covers. On the top of the scrubber is placed a cistern, for the purpose of containing the oil that is needed for scrubbing the gas.

In the working of the process, the temperature to which the retorts are heated necessarily depends on the nature of the oil that is being decomposed; but in every case it is considerably lower than that which has hitherto been employed when oil was gasified at one operation. For instance, with ·885 "blue oil," which is being used at Galashiels, and has also been largely employed at Peebles, the most suitable temperature on the outside of the retort, with the retort producing an average quantity of gas, was found to range from 1200° to 1300° Fahr.; while the internal temperature, at a point in the centre of the retort 4 feet distant from the mouthpiece, was from 900° to 950° Fahr.* With blast-furnace oil and coal tar, the temperatures are considerably higher. When the retort is in operation, the internal temperature is regulated by the rate of the flow of oil into the retort, and with each particular oil it varies within a narrow range; but the external temperature may vary through a wide range, according to the amount of work being done, or, in other words, to the make of gas per unit of time.

The retorts having been heated to the desired temperature, and the scrubber, the hydraulic main, and the rest of the apparatus been charged with oil, the oil is turned on at the regulating-valve K, and allowed to flow by the syphon-pipe into the stand-pipe D; and thence along the inclined bottom of the retort. Now, if what was stated in the previous paper regarding the complex mixtures of the oils used and the varying boiling-points of their different constituents be kept in mind, it will at once be evident that, as the oil flows down the inclined retort, these constituents are volatilized in the order of their boiling-points at distances farther and farther from the mouthpiece, and that thus the vapours into which they are successively converted are subjected to increasingly higher temperatures for gradually longer periods of time. The rate at which the oil is allowed to flow into the retort depends, in great measure, on the nature of the oil being decomposed—being greater in proportion to the percentage of carbon that requires to be eliminated. But the oil must flow at such a rate that only a part of it is converted into permanent gas at a time, while the remainder, being but partially decomposed, leaves the retort in the form of vapour. The exact rate of flow, however, is very readily ascertained by the appearance of the partially

* These temperatures were determined by a Siemens copper ball pyrometer. In the case of the internal temperature, the copper ball was introduced by means of a tube fixed in the retort-lid.

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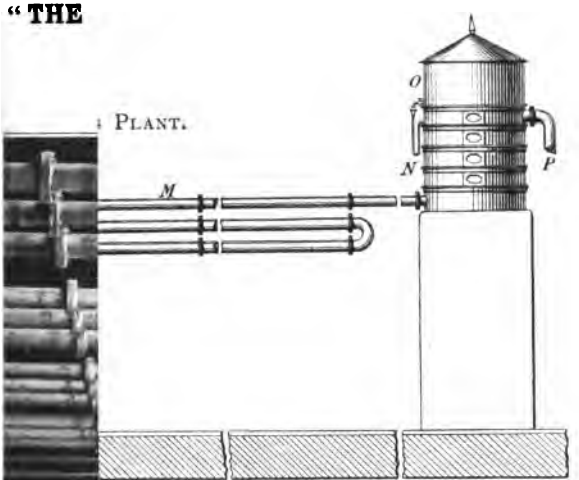
VIEW OF RETORT-HOUSE FITTED WITH PEEBLES I

"THE



PLANT.

D Stand-pipe and dip-pipe. E Hydraulic
ain. H Main oil feeding-pipe. K Regulating-
ntal condenser. N Oil-gas scrubber. O Oil-

erent Specific Gravity and Constitution.

	Illuminating Value.		Yield of Coke.	
iching lles per Ft.	Candles per Gallon.	Sperm Value, Pounds per Ton.	Pounds per Gallon.	Cwt. per Ton.
	1530	6635	2·52	5·70
	1613	7329	2·09	4·94
	1573	6959	2·31	5·32
	1149	4552	4·00	8·25
	398	1365	7·62	13·61

PATENT C

decomposed vapours, when a portion of the same is allowed to escape through a stopcock on the retort-lid. These vapours, when in their normal condition, should be of a pale yellow or straw colour; but, if the feed of oil be too small in relation to the temperature of the retort, the escaping vapours are more or less brown in colour, owing to their being over-decomposed and loaded with sooty carbon—which, of course, is detrimental to the process, and would probably lead to choking of the apparatus. In practice, however, the appearance of the condensed oil when returning to the retorts, and the condition of the interior of the retorts when they are opened for removal of the coke, are sufficient indications to guide the workmen in regulating the flow of oil.

When the gaseous products leave the retort, they are met in the stand-pipe by the inflowing oil, and are practically freed from any sooty carbon they may carry in suspension. They are next washed, while bubbling through the oil in the hydraulic main; and there the least volatile portion of the partially decomposed vapours is condensed. The remaining products then pass on to the condenser and scrubber, where, by gradual cooling and washing, the most volatile but still condensable vapours are removed; and finally the remaining gas leaves the scrubber by the outlet-pipe P in a thoroughly permanent condition. From the scrubber, the gas passes through a small station meter, after which it is mixed with the low quality coal gas at the inlet of the purifiers. During the whole operation of cooling and scrubbing the products from the retorts, the partially decomposed vapours are being gradually condensed—the least volatile first, the most volatile last; and as they become liquid, they return in an opposite direction to the hydraulic main, whence they pass by the pipe G to the compensating and settling tank F. In this tank any solid carbonaceous matter in the oil which would tend to choke the regulating-valve K is allowed to settle; and, when necessary, it may be drawn off by a stopcock at the bottom of the tank. A supply of fresh oil, equivalent to that which is being permanently gasified, is automatically admitted to this tank, by means of the supply-pipe and ball-cock L; and this fresh supply, together with the condensed oil, flows through the main feeding-pipe H to the regulating-valve K, by which it is fed into the retort.

In this manner, the oil which is introduced into the apparatus, after serving as a washing agent to remove the condensable matter from the outflowing gas, finds its way into the retort, where, by the action of the heat, it is partially decomposed in

the fractional manner described; and the resulting products, as they pass upwards through the apparatus, are simultaneously subjected to gradual cooling and condensing, and to the washing action of the down-flowing oil. By this means the permanently gaseous part only of the products, which has withstood the action of the final washing with the fresh oil that is periodically pumped into the scrubber, is allowed to pass away; while the condensable part is returned to the retort, and is again and again subjected to this process of alternate decomposition and condensation and scrubbing, with the result that the original oil is completely split up into permanently gaseous compounds and solid carbon, the latter of which is left in the retort in a hard and dry condition.

The working of this process is remarkably simple, and is so far automatic in its operation that very little labour is required. In the case of the Galashiels plant, the heating of the retorts is, as I said before, done entirely by the low heat from the coal-gas setting; and there is thus practically no labour required in the heating of the oil-gas retorts. In other respects, also, the works at Galashiels are well situated for carrying out the process. The oil is delivered in tank-waggons on a high-level railway, and flows by gravitation into store-tanks. From these, it flows, also by gravitation, into the compensating tank, whence it is fed into the retort. The only oil, indeed, that has to be pumped is that which is needed for washing the gas in the scrubber. Altogether, very little labour is required; all that is necessary, besides that already stated, being a little attention to the regulating of the flow of oil into the retorts, and the withdrawing of the coke as it accumulates. Of course, more labour may be needed in some works than in others; but in all it will be exceedingly little, and very much less than that required for the manufacture of coal gas.

The plant having been described, and the working of the process having been explained, the members will now be desirous of gaining some information regarding the practical results of the process. Accordingly, I would ask their attention to the accompanying table, in which are summarized the results obtained from the decomposition of various oils differing in specific gravity and constitution.

With reference to the gases obtained from the "blue oils" and the crude shale oil, they are, as will be seen, exceedingly high in quality, and have a specific gravity of about 970 (air being 1000). They require very little purification, as they contain only a trace of sulphuretted hydrogen. Further, the coke

from these oils is of a hard, dense nature, is very free from sulphur, and contains only 0·3 per cent. of ash. It is therefore very valuable.

The results which are given for blast-furnace oil are the average results obtained from the working of it at Peebles for over two months, during which time it alone has been used for enriching purposes. In decomposing this oil, no difficulty whatever has been experienced; but a higher temperature is necessary, compared with that employed in the case of "blue oil." The gas which it yields is also very free from impurities; but it contains about 13 per cent. of carbonic oxide, resulting from the decomposition of the hydrocarbon compounds containing oxygen. The coke, although scarcely so dense as that from "blue oil," is likewise of considerable value.

In dealing with coal tar, the existing fire-clay coal-gas retorts at Peebles have been modified so as to adapt them to the principles of the process. They also are laid with an inclination downwards; and the tar is admitted to the standpipe by a regulating-cock and syphon-pipe. It is run into the empty retorts at such a rate that the internal temperature is considerably reduced, and that only a small portion is converted into permanent gas—the remainder, after condensation, being returned along with the newly-made tar again and again to the retorts, until the whole is finally converted into gas and coke. None of the difficulties hitherto met with when gasifying tar—such as choked pipes, &c.—have been experienced by this process; and the condensed tar in circulation, so far from becoming pitchy, actually becomes more and more liquid. A sample drawn from this tar in circulation yielded when distilled 10 per cent. of light oil, boiling under 400° Fahr.; while the original tar contained only from 3 to 4 per cent. of such oil. The gas produced from splint coal tar contains 10 per cent. of carbonic oxide, and about 1½ per cent. of carbonic acid and sulphuretted hydrogen combined. The coke—a large quantity of which is produced—is easily withdrawn from the retort, and is also valuable as a fuel. The results in the table are the average results obtained from the gasification of the whole of the tar made from splint coal at Peebles during the past two months.

In coming to the question of the relative cost of enriching coal gas by means of liquid hydrocarbons and cannel coal or shale, there are so many modifying circumstances to be taken into consideration—such as the cost of crude materials together with their carriage, the price of labour, the quantity and the quality of the gas, and the like—that it is impossible to give a

detailed statement. But the results given in the foregoing table will enable each member for himself, after considering his own surroundings, to estimate the value of the process for his particular works. And, besides, the members, I have no doubt, are all familiar with the comparative statement of costs contained in the "Report on the Manufacture of Gas from Oil," by Mr. Linton, of Leith, which has appeared in the pages of our technical journals.*

One thing I may say, before concluding, and that is that, whereas by all processes hitherto in operation only oils of a light and semi-refined nature could be used, by the Peebles process oils can be employed of whatever density and crudeness. This is no slight advantage; for while, in the one case, the supply of oil must be limited, in the other that supply is practically speaking inexhaustible. When it is considered also that this matter of supply bears directly on the question of cheapness, it will be evident to every one, I think, that the Peebles process is of considerable value, as it will at the very least enable gas manufacturers to hold the balance between the two commodities employed for the enrichment of gas—between cannel coal, on the one hand, and oil on the other.

Mr. J. MACKAY read the following addition to his paper, read at the previous meeting, on

ENRICHING COAL GAS BY PARAFFIN OIL OR LIQUID HYDROCARBONS.†

When I prepared my paper last year on enriching coal gas by oil, I did not expect to have the pleasure of listening to the two very able and interesting communications just read by Messrs. Young and Bell. The process they have described differs entirely from the one adopted by me; and therefore I am not in any better position to discuss it than those who have given the matter only ordinary consideration. In my opinion, Messrs. Young and Bell have handled their subject in a very masterly and thorough manner, and deserve every success in their undertaking. As I mentioned last year, I was partially driven to the use of oil for enriching, and had to employ the materials which came readiest to hand. Were I again placed in similar circumstances, I should do exactly the same thing. The first cost is trifling. No alteration of plant is required, and no extra labour is involved. But notwithstanding all this, I

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* See *Journal of Gas Lighting*, Vol. LXI., p. 738.

† See "Reports of Gas Associations" for 1892, p. 206.

should not suppose for a single moment that the process would compare economically with the very complete system which has just been described by Messrs. Young and Bell. Theirs has been carefully devised and thought out. Mine was rushed into; and unexpected results were obtained—results which, I hope, justified me in submitting my paper, as showing the possibilities of oil as an enricher. During last year, we succeeded in improving our working very considerably. In March, we made a working test of the oil, and obtained 25,500 cubic feet of 42-candle gas per ton. Formerly we obtained 17,000 cubic feet of gas, estimated at 50 candles. Everything depends upon how the oil is injected. The less injected into the retort at a time, the better is the result. With a decreased temperature in the retort, the percentage of tar rapidly rises. Careful working gives about 18 per cent. of a very thin tar, which mixes well with coal tar. Our refined tar was shipped to Germany in the usual course during the spring; and it gave unmixed satisfaction to the dealers there.

Discussion.

Dr. STEVENSON MACADAM (Edinburgh) said he would have preferred that some practical man should have opened the discussion, so that he might have had an opportunity of stating his views on the subject now before the meeting. It was one with which he was very familiar; and it was also one which he thought he ought to congratulate the Association on having made their own. The fact was that twenty-one years ago—they were now in the majority of the question—he had the honour of bringing the matter before the Association, at a meeting which was held in Perth in the year 1872; and it was then a subject which was more concerned with scientific inquiry than with what they might regard as practical use. In the interval, however, they had had the thing threshed out in many ways, with the result that they had had a great deal more light thrown upon it; and he was very glad to find that in this, the majority year, it had become a thoroughly practical question. The observations made by Mr. Young were extremely interesting on the general principles connected with the breaking up of the oils, either into more useful and thinner oils, or into permanent gas; and he did not know that there were any points—there were certainly none of greater importance—as to which they would differ in regard to the constituents in the breaking up. Consequently, his observations would be more in the way of requiring, or at least of asking for,

some fuller information respecting the paper which was read after Mr. Young's communication, and which was the practical one. This subject had been experimented upon, not only in the chemical laboratory, but also with large apparatus, on a practical scale; and he had to do, from time to time, not only with the carrying out of his own experiments, but with the taking of very careful superintendence, and accurately estimating the results which had been obtained by some practical methods. And he had to say this—that he was quite agreed, in the first instance, with the prominence which was given to blue oil as the one which could be best employed in the production of this gas. He also agreed, practically, with the large proportion of gas that was obtained from the blue oil, and the quality of the gas. The fact was that, when this matter was in its infancy, the question arose as to the kind of oil to be employed in experiments for the production of permanent gas. He worked with all kinds of oil—not only with crude, but also with green oil, which was a sort of semi-refined material; and they ultimately came upon the blue oil, some fifteen years ago, as that to which they should confine their experiments. It was then a sort of drug in the market—at all events, it was a material which could be purchased at a reasonable price. Further, it had the advantage of being purified to a considerable extent, in respect of the tarry matter being taken out of it. They found that the results they obtained, and the photogenic value, were very good; and consequently he was pleased to see the results obtained from the blue oil in this process. The question as to the breaking up of the oil into permanent gas was one which they might say lay at the foundation of the whole subject. In the earlier experiments—those which were conducted twenty-one years ago, and which were necessarily only early experiments—they had to work without knowing very well the modes of operation at the time. In all these earlier experiments, the method of working was to pass the oil over—dropping it on to—a red-hot material, and to send it through a red-hot material, to vaporize the oil, and then to transmit it, in vapour, through a hot substance such as coke. Those who cared about investigating the matter would find it in the Transactions of the Association for 1872.* Those experiments yielded a considerable quantity of permanent gas; but they did not give the larger proportion which was obtained now. They had a gas which had not so high an illuminating

* See *Journal of Gas Lighting*, Vol. XXI., p. 763.

power, and one which had not such permanency in regard to retaining its illuminating power. For instance, on the second day, condensation had taken place, and the quantity and quality was much reduced; and on keeping it for four days, it was still further reduced. But after these earlier experiments, there came the question of breaking it up, without passing it through a body of red-hot material such as coke; and in all the later experiments, as regarded the last fifteen years, which he conducted himself, and which he had seen conducted and taken note of in every way, they had had the substance broken up practically in what Mr. Young referred to as radiant heat. It had not been transmitted through any body of red-hot material in the form of vapour, nor had the vapours been allowed to impinge upon a large body of red-hot material. The consequence had been that the principle upon which these oils should be broken up had been conducted, so far as he knew for the past fifteen years, in regard to the product which was obtained, by the process now described to them. That product was one to which he should wish particularly to refer—the quantity of gas and its illuminating property, and how far they had extracted out of the paraffin oil the photogenic power which the oil was capable of yielding. In such cases, of course, the mere quantity of gas could not be taken as the only factor; they must likewise consider the photogenic power —the light-giving power—of the gas. He found it was stated in the table that the candle power, very properly expressed as an enriching agent, was 90 candles. Of course, this was enrichment, which, if there had been time, the author of the paper would have clearly explained. This enrichment was not actually the light-power of the oil gas they obtained by the process, but was the light-power they had when they mixed it with thinner gases, and then determined the photogenic power of the mixture. Practically, the result—and Mr. Young would bear him out in this—was that he obtained 60-candle power gas from his apparatus; and then he had very properly put it there that the enriching power went up to 90 candles. This arose from the fact that the gas was so very rich in the heavier hydrocarbons that, in order to consume it properly, and get the full luminosity out of it, they required to burn it with a poorer gas. A much easier method of calculating the productions was to take the sperm value. This was given as 6635 lbs. of standard sperm candles per ton of the oil they employed. This, of course, was on the enrichment theory; and it was an enrichment fact, because he quite admitted the enrichment. Well, then, that

was the full quantity of light they obtained when they mixed it with thinner gases. But if they took the gas by itself, they, of course, had to reduce it from the 90 to the 60 candles; and this brought down the sperm value to about 4500 or 4600 lbs. Now if he compared the amount of light obtained by this process with that which was obtained by other methods he had thoroughly investigated, he found that practically the same result was arrived at; and he did not see where there was any great increase of light-power in using this apparatus, as compared with others. He was not, at the moment, concerned with the working of the apparatus, which was a question for practical men; but the result was that, using other practical methods, they obtained as nearly as possible the same amount of light as was shown in the table, and working, let them remember, with a similar oil. He wanted to be very careful about this, because there might be what was called blue oil and blue oil; but the oil he was working with was of ·877 to ·878 specific gravity, so that it was practically a blue oil. It was very important to consider the illuminating power with regard to the quantity of gas, and the illuminating power they had from the gas; still he could not see where a much better result was obtained, practically, so far as regarded the light-power they had from their blue oil. Another point to which he should like to refer was the influence of what was called distilling at a low temperature, and then re-distilling; or what he might call re-churning the material over and over again. He was not so sanguine as Mr. Young and Mr. Bell seemed to be as to the great benefits to be derived from this. They had the oil split up, and only partially (as they all admitted) converted into permanent gas. In great part it was condensed in the apparatus, and flowed back to the retorts. In considering this point, they had to take along with it the large amount of carbon which seemed to be deposited in the Young retorts. It was 5½ cwt. per ton of oil. This was an enormous quantity of carbon. He did not know how far it came from the actual oil employed, or whether it was obtained from those products which had been condensed and run back into the retort. It was probably more from this than from the actual new oil which was run in along with it. But this proportion of carbon appeared to him to be extremely large; and whether or not Mr. Young's process were ultimately adopted as the best, he thought they must have a modification of it, so as to try to reduce this large quantity of carbon. There seemed to be an enormous amount of waste, when, in distilling a ton of material, more than 25 per cent. was

left as black carbon. They did not care whether it was very suitable for firing or for other purposes. What he wanted was to convert it into illuminating gas; and he thought it would be their duty to endeavour to reduce the carbon as much as the authors could. He had only one word further to say, in respect to the different oils they found suitable. A crude shale oil did not yield them so large a result as in Mr. Young's apparatus. Of course, it contained a lot of very light liquids, and also tarry matters; and these reduced the possibility of converting it into permanent gas. While making these observations, he wished to say how much pleased he was that Mr. Young and Mr. Bell, and other practical engineers, were devoting their attention to the important subject before the meeting. He quite agreed with them that it was one in which lay the future of the enrichment of gas at a reasonable cost; and therefore the more it could be brought before them, and the more thoroughly they discussed it and threshed it out, the better it would be for the manufacture of gas.

Mr. J. HEPWORTH (Carlisle) said he did not propose to discuss the papers, to which they had listened with much interest; but there were one or two questions which he would very much like should be answered. In the first place, he wished to know whether any experiments were made with Russian oil, and what the results were in comparison with those shown in the table before them; and since no figures had been given as to the commercial value of the process, perhaps Mr. Young or Mr. Bell would say what quantity of gas per mouthpiece could be produced per 24 hours. He should also like to ask whether, especially in the last experiment there detailed, with splint coal tar, the retorts used were of clay; and since the quantity of coke from this experiment was considerable—13·61 cwt.—he presumed they might take it that the value of the coke was at least as good as that of the coke produced from ordinary splint coal. He thought, if they had answers to these questions, it would help them very much in arriving at some conclusions which were important in this matter.

The PRESIDENT intimated that, as they would possibly have a good many questions, perhaps Mr. Young would like to answer these at once.

Mr. YOUNG said he would be very pleased indeed to do so. As regarded Russian oil, he might say that they had not tested any of it on a scale upon which he would care to give any definite results. They had made experiments, but the results that had been given to the meeting were those which they had

obtained upon a practical scale; and he would not like to come before them with mere experimental results. With regard to the tar, their contract prohibited them from using it up to a certain time. They had now used all the tar they had made; and the way they had utilized it was simply to collect it, and pump it into an elevated tank, and they used the existing brick retorts at first, by simply filling the mouthpiece with a piece of brick, with the object of compelling the tar to flow on to the heated surface of the retort. They found this to work so well, that they immediately took out one of the settings, and placed the new retorts at an inclination of something like 4 inches upon the 9-feet retort. This had the effect of causing the tar to flow back, and prevented the nuisance they had in its lodging in the mouthpieces, and giving trouble when taking off the doors. The results obtained had been arrived at in this way: In the first place, they took the quantity of gas which they had been getting from the splint coal previously; they then took a quantity of tar, and worked it in separate retorts, but measured the resulting gas in conjunction with that obtained from the splint coal, and calculated out the augmented volume and the increased illuminating value realized by the use of tar in that way. Then, as a check experiment, they fitted up a retort which could decompose a gallon of tar in an hour; and they carefully measured the gas. They collected the whole quantity, and made an analysis of it. They found the results were substantially identical with those they had obtained on the commercial scale; and they then thought themselves fully warranted in giving those with regard to the value of the coke from the tar. The coke came out with a ringing sound. It was quite hard; and it was thoroughly bound together in a mass. It came away perfectly free from the walls of the clay retort. A very large shrinkage took place; and it was just as easily removed from the retort as if a charge of coal had been put in. Of course, they could judge for themselves, from the very appearance of the coke, as to its value as a fuel. They had to check the draught; otherwise they would melt down the whole setting. By simply keeping the draught a little lower, they obtained the desired temperature. They found that the more frequently the oils were subjected to decomposition, the better the results; the smaller the increments in which the oils were decomposed, the higher were the results. Then with regard to the quantity of gas made per mouthpiece, they had a letter from Mr. Scott, of Galashiels, wherein he said: "We have now had a nine weeks' trial of the oil gas, and during the whole time it has given entire

satisfaction. There has not been a single hitch since we commenced. I may mention that, by way of experiment, we raised the heat on Friday and Saturday last, to see what quantity of gas we could make. We were then making 4000 cubic feet per mouthpiece per 24 hours; and with the increased heat we made 6000 cubic feet in 12 hours, which, I am sure, will answer our purpose in a push during the winter months."

Mr. D. TERRACE (Middlesbrough) said he had not intended to speak upon these papers, because of the position in which he was placed. It was not at all likely that oil would bear such an important part in England as it would do in Scotland, because an increase of 5 candles would be of more importance to managers in the latter country than a single candle would be to them in England. But he was very much interested in the lower line of the table—to think it was possible, from the tar which they almost gave away just now, to get the sperm value indicated. If they added this to what they obtained from the coal originally, it gave them nearly four times the sperm value of the coal—a result which, he thought, appealed to all their senses. If they could possibly convert all their hydrocarbons into light, it would be a great gain. In regard to what Dr. Stevenson Macadam had said about the carbon left in the retort, he thought they would much rather have it in this form than as soot, which they used to have. Mr. Young seemed to have been able to convert it into carbon instead of into soot; so that whether or not the quantity of real coke were excessive, he should say they would all have it in that way than otherwise. He understood this was in reality the *crux* of Mr. Young's paper.

Mr. A. YUILL (Alloa) remarked that there was one question he should like to ask—viz., about the volume of coke produced per ton of oil. Dr. Macadam seemed to have thought 5·7 or 4·9 cwt. excessively high. Dr. Macadam might know that, in dealing with hydrocarbons, in the opinion of some, before they were able to split up the gases, they must separate a percentage of carbon. What he would like to ask either Dr. Macadam or Mr. Young was, if they could give them any idea as to the minimum percentage of that decomposition. If it were not possible to do away with the carbon altogether, then what was the minimum percentage of carbon they could possibly get?

Dr. MACADAM replied that he could not give this in exact figures; but he might say that, in the experiments he had made on a practical scale, they had nothing like that proportion of one-fourth of the material left. The question arose as to the

minimum; but he had seen these retorts, after working twelve hours, taken out, and simply a little carbon scraped out of them. Of course, he quite understood that, in the circumstances to which he had referred, a considerable proportion of the carbon was passed off in the form of smoke, which was condensable in the condensers; but his own impression was that 25 per cent. of the original material was excessively high.

Mr. A. MacPherson (Kirkcaldy) said they must all feel very much indebted to Mr. Young and Mr. Bell for the papers they had given them; and he was sure this oil-gas process would, sooner or later, take its place in the gas-works of the country. Suppose it were for nothing else than as a stand-by, they would be justified in introducing it; but if its merits were so conspicuous as they had been told that day, he thought they would adopt it as a means of enriching poor gas, and thereby enable them to check the price of high-class cannels. With regard to what Dr. Macadam had stated, he thought he had proceeded upon a wrong basis as to the 90-candle power. He (Mr. MacPherson) understood that the illuminating power was in reality 90 candles. Then, with reference to Mr. Yuill's and Dr. Macadam's question in respect to the coke which was left, he had no doubt that a limit must be found. They could convert a certain amount of the hydrocarbons into permanent gas, but the process necessarily involved a deposit of carbon; and while Dr. Macadam said that he had much less coke, what about his tar? They had no oil tar in this system. But he thought that Dr. Macadam would find he had a considerable quantity in his process; and possibly, if the tar were added to the weight of the coke, it would be found that they would not be very far apart. The only drawback he could see to the process was that the whole coal they would use would be coking coal, and they might have some difficulty in disposing of the coke at a reasonable price; and where, as was generally the case, the space in gas-works was very limited for the storeage of coke, this might be a very serious drawback. He thought that, in estimating the commercial value of the gas, the value of this coke was taken at from 7s. 6d. to 8s. 4d. per ton. If they augmented the coke they had for sale by something like, he should say, three or four times the quantity they had at present for disposal, he did not see where they could find a very ready market for it; and consequently, if they did not get a ready market, they could not receive anything like 7s. 6d. or 8s. 4d. per ton. In estimating its commercial value, they would require to judge of its value according to particular circumstances; but in regard

to the process for the conversion of oil into a gas for the enrichment of coal gas, in his opinion Mr. Young had solved the difficulty in a unique manner.

Mr. YUILL said, as one of those who were taking up the oil process, he might state that he had been looking out to see how he could get the coke disposed of; and, on making inquiries, he found that what they required in iron foundries was a hard, dense coke, with a low percentage of ash. The thought struck him that the coke produced by the Peebles process contained all these properties. At present, iron-founders were paying 22s. per ton for ordinary coke, with 2 per cent. of ash; and they were quite willing to take the coke produced by the oil-gas process, as soon as they started to make it, and pay 20s. per ton for it.

Mr. D. M. NELSON (Glasgow) remarked that their friend Dr. Macadam had drawn attention to the enormous quantity of coke that was left as a residue by the Peebles process. Some of those present would remember a little newspaper correspondence he had as to that; and he thought it due to his friend Mr. Young to say that, being engaged in a matter in which the result was to produce the highest quantity of gas, this prompted him to call in question Mr. Young having so large a residue as 5 cwt. of coke per ton of oil. In the correspondence, he also called attention to the fact that the coke did not burn. He found, however, that the piece of coke he had in his hand was very different from the coke Mr. Bell sent to him.

The PRESIDENT: That is tar coke.

Mr. NELSON said he was very glad he had raised the question, because it made the matter clear; and he found that others besides himself were of the same way of thinking. The coke he had now possessed more of the density of that which he had sent to him from Peebles. The point he was dealing with was the fact that so much of the coke was left, and, instead of being converted into gas, which was really the business of the man engaged in enrichment, that it should be relegated to the parlour fire. He found, upon the authority of their friend Dr. Macadam, that he could not have been very far wrong, because they should take the most out of the material that was furnished to them. He was quite certain Mr. Young had ingenuity and skill enough to do this, if any man could do it; and he thought it due to him, to say that it was from no spirit of fault-finding, but with a desire that the coke should be converted into gas, that he wrote what he did.

Mr. A. BELL (Dalkeith) remarked that he would very soon be in the position of having had experience of the Peebles process,

because they were busy erecting the plant for it. Dr. Macadam had stated that the blue oil he used was semi-refined. His (Mr. Bell's) experience was that they did not wish for refined oil, and that any unrefined oil would do. The former, by being washed with sulphuric acid, must contain sulphur, which crude oil would not. Then, with reference to the coke, their friend Mr. Nelson had not yet got the "grip" of that. When carbon was contained in the oil as a liquid hydrocarbon, they did not want it in that condition. They were not oil manufacturers, but gas manufacturers; and to make a gas suitable for burning, they must take out a quantity of the carbon. This was the carbon which could not be made into gas. It could not be a working gas and contain this excess of carbon. With reference to the burning properties of the carbon, of course it was perfectly suitable for burning, only it must be broken small. He presumed that Mr. Nelson could not burn the sample sent to him because he did not break it. Dr. Macadam said that he had never obtained 5 cwt. of coke per ton of oil. He (Mr. Bell) granted that; but Dr. Macadam never worked in that particular manner. He worked, he supposed, in a small experimental way. A portion of his coke went away as tar, and also, as Dr. Macadam himself owned, as smoke. As gas manufacturers, they did not want this. They knew where it went to; it choked up their ascension-pipes and everything else. They wanted it in some portable form, in which they could take hold of it. They did not wish to have it spread all over their works. At Peebles he had had the pleasure of seeing the process at every stage. He had watched it very carefully, not only in the retort, but throughout; and he had never found anything in the boxes. He was able also to state that everything that had been put before the members that day was correct.

Mr. R. MITCHELL (Edinburgh) observed that this was a subject in which he had taken very considerable interest since it was started; and perhaps he might be permitted to lay before the meeting the result of some experiments which were conducted on his instructions at Peebles. The question had been asked of him as to what was the cost per 1000 feet of gas made from the oil used in the apparatus; and he would read the following passages from his report to his Commissioners:—

I have prepared a statement showing what I would consider as fair average cost for enriching coal gas from 16 or 18 to 30 candle power. One ton of coal, producing 10,000 cubic feet of 16-candle gas, costs 10s.; deduct for tar and liquor, 1s. 8d.; coke, 1s. 3d. = 2s. 11d.; net cost of 10,000 cubic feet of 16-candle gas, 7s. 1d. A thousand cubic feet of 16-candle power gas costs 8·5d. One ton of ·891 specific gravity oil = 251 gallons, costs £2 10s.;

deduct for coke, 5·18 cwt., at 20s. per ton, 5s. 5d.; net cost of 251 gallons of oil, £2 4s. 7d. One gallon = 92·64 cubic feet of gas, costs 2·132d.; 1000 cubic feet of oil gas cost 23d.

He had a table there, showing the difference in the cost of the various qualities from 16 up to 30 candles. In the closing paragraph of his report, he said:

In conclusion, I may be permitted to state that I am of opinion that this process is destined to become an important factor in gas-works where a high illuminating power gas has to be supplied, and is well worthy the consideration of the Commissioners whether a trial apparatus should not be erected at their works.

Since this report was laid before his Committee, plans had been prepared, and were now completed, for the installation of altogether 21 oil-retorts on one side of the bench, and 28 ordinary fire-clay retorts on the other, which could be employed for the distillation of coal or the breaking up of coal tar into gas, so that they would be able to know exactly the cost of it, and the advantage of the application of it; and he hoped he might be able at some future time to lay before the Association the result of his experience in this direction.

Mr. J. M'GILCHRIST (Dumbarton) stated that, as Dr. Macadam had pointed out, they had had twenty-one years of oil gas; and while, previous to last year, they were somewhat sceptical as to the use of oil for gas-making purposes, he thought that oil gas was now within "the region of practical politics." He considered Mr. Young had, to a large extent, solved the problem of how to make oil gas. That gentleman was no novice in the matter of manufacturing gas from oil, because a number of those who were then present had been associated with him for many years in the work. They began in a very crude way; but they had worked up to what might almost be called a perfect system. The only thing was, Would it pay? This was the great difficulty. While they talked about the production of coke being in the wrong direction, he did not think that, when this process yielded a coke which could fetch in the market 20s. per ton, they could call it altogether a waste product. Indeed, he considered they might look at it in the other directions. But the question came in, if they were all going to use oil in the manner which had been advocated that day, would it remain at 2d. or 3d., or even, as the President had said, at 4d. per gallon? They knew very well that the law of supply and demand would come into play; and if oil got to be beyond their reach, the plant they might erect at their different works would be of very little use. They were told that large supplies

of oil might be obtained from Russia. He trusted that some of the gentlemen who had taken up the new plant would thoroughly test the Russian oil, and possibly, if it were as successful as Scottish oil, they would have less hesitation in deciding as a body to adopt it. He thought they would all wait to hear the result—possibly next year. Their friend Mr. Mitchell had just promised a paper on the results to be obtained in the Edinburgh works; and he had no doubt Mr. Yuill and others would be able to give them the results of their working. If there was a fault in the papers they had heard, it was, in his opinion, that the authors had given the meeting nothing to lay hold of in the matter of cost.

The PRESIDENT remarked that he would very much like to hear Mr. Tocher, of Peterhead, make a few remarks. Mr. Tocher was kind enough to explain Mr. Mackay's paper most thoroughly to them last year; and he thought he would be able to say something interesting on the new development of the oil-gas process.

Mr. TOCHER said he was very much interested in the discussion, as well as in the two valuable papers given by Mr. Young and Mr. Bell. It had, without doubt, entailed a great deal of experiment to arrive at so satisfactory a process; and the results it gave were excellent. A yield of 21,500 cubic feet of 90-candle gas per ton of oil was certainly satisfactory. He wished to ask if Mr. Young had tested the candle power—the photogenic value—of the oil gas alone, and found it to be 90 candles.

Mr. YOUNG said he might state at once that the 90 candles represented the gas when burnt at the rate of 5 feet per hour.

Mr. TOCHER went on to say that the adoption of the process would entail the erection of special plant; and this might cause gas managers to wait until a favourable report was given by those who were trying the process. Mr. Mackay had laid before them the results he had obtained Without, of course, professing to be a process at all like Mr. Young's, Mr. Mackay's method was more simple, and it effected its purpose, which was to produce economically and at any time, a gas of high illuminating value, without interfering in any way with existing plant, and without damaging the tar. Last year, at their President's request, he made a few remarks regarding Mr. Mackay's mode of working; and at that time he spoke of the probability of imperfect gasification being the cause of some of the difficulties they had to contend with. There was now no doubt whatever that the larger the proportion of oil was to the ton of coal (one mouthpiece only being used), a portion of the oil passed over

unchanged; and this caused the apparent discrepancies in the candle power given at the time. This had now been obviated by injecting the oil very slowly, and at a higher pressure, into the retort. He did not notice anything very remarkable in Mr. Young's process, as compared with Mr. Mackay's. They expected to give some further results at that meeting; but they had both been prevented from doing so by pressure of other work. They hoped, however, to be able to have them by the end of the year, and to have formed an opinion as to the yield by Mr. Mackay's method, which was not very much of a process, but merely an application.

Mr. D. VASS (Portobello) said he should like to ask Mr. Young a question with reference to the retorts. No figures had been given as to the cost. The retorts used at Galashiels were cast iron. Would there be much difference in expense in using steel retorts instead; and would there be any greater durability in them? Then he should like to know if there would be any danger from a cracked retort. The material at the end of the charge, prior to drawing it, was in a liquid state; and, in the event of the retort cracking, there would be a few hundredweight of liquid matter in the retort. If a retort were cracked in the bottom, would this be a source of danger? or would it be a source of danger if there were condensation, producing a vacuum? Then there was one point in Mr. Young's paper which struck him as being applicable to existing plant, and that was the action of water in shale—water in the presence of hydrocarbons. He had never understood water in shale to have such a deteriorating effect. They had understood the effect, but not how it came about. The reason for their having such bad results from working with wet shale—more so even than when working with wet cannel or splint coal—was very well brought out in Mr. Young's remarks.

Mr. A. BELL (Dalkeith) said, with reference to the extra cost of the plant necessary for the process, he might state that a gentleman had proposed to erect the plant and take his payment out of the savings for a year. This showed that the additional expense should not interfere very much with the adoption of the process.

Mr. A. WILSON (Dawsholm, Glasgow) thought that the members were all very much obliged to Mr. Young and Mr. Bell for bringing before them the subject at present under discussion; and the Association as a body were indebted to them for reserving their papers for the present meeting. Mr. Young's remarks showed that a master was dealing with the subject. It seemed

to him (Mr. Wilson) that the great point about the Peebles process and about the apparatus was the workability of it. The whole thing, from beginning to end, was thoroughly under command. The results were certainly exceedingly good; but still he thought, in the matter of illuminating power, there was a point which wanted clearing up. As he understood it before, the illuminating power stated was only obtained by mixing the rich oil gas with ordinary gas; if the gas were tested by itself, he did not think they would get 90 candles. This was the impression he had before.

The PRESIDENT: That is admitted; it is impossible to test a gas of that power.

Mr. WILSON (continuing) said this made the matter quite clear, because it was plainly shown on the diagram that the gas was taken as an enriching agent; and, if they tested it by a photometer, he did not think they could get the illuminating power stated. There was a question raised by Mr. MacPherson about the coke. He (Mr. Wilson) did not think there need be any fear of not getting a sale for the coke. If they could use oil, and do without cannel or shale, the coke would be of better value, and be more easily got rid of than now. The cost of the apparatus was not very great; and to him the crucial point in the matter of cost was what the price of oil would stand at. If the oil would keep at a reasonable figure, he did not think there need be any fear of the system not coming into general use. Of course, taking it on a large scale, it might not be so suitable for big works, where space was a great consideration. The floor-area for a system of this sort must certainly take up a large portion of the works—quite, or very nearly, as large as was required for producing the same amount of gas by a coal-gas plant; and it was just a question, where space was much wanted, whether a water-gas system, enriched with oil, would not be more suitable. But, of course, this again was a question of cost. Perhaps by the time they met as an Association next year, if the subject was brought up again, they might have some further light upon it.

The PRESIDENT thought it would be presumption on his part to attempt to add anything to the two excellent papers they had heard, and the most interesting discussion which had followed; but possibly he might be allowed to ask a question. It had been put to him several times in this way: Should they carbonize oil, or should they not go straight for the shale—put the shale into the retorts, and carbonize that, instead of making two processes of one? He could see through this argument.

For instance, if they took the shale and carbonized it, they could only produce a gas, at its very highest, of about 40-candle power; whereas if they took the shale in its condensed form as oil, they could make gas of twice this quality—of, say, 80-candle power. He should like to ask Mr. Young this question: From a ton of oil they could produce about 22,000 cubic feet of 80-candle gas. While it would hardly be fair to put a ton of shale against a ton of oil, perhaps Mr. Young could give them a statement as to how many tons of shale it required to produce gas equal to that made from a ton of oil, and tell them what they would gain by carbonizing the oil in its condensed form, instead of going straight for the shale. He supposed that the oil-retorts took up the same space in comparison with the coal-retorts; but they must look at the extra work they obtained from an oil-retort. As Mr. Young had stated, they could make about 12,000 cubic feet of gas per 24 hours with one oil-retort; and he did not believe they could approach this quantity with a clay retort, in making gas from coal. Then there was the coke difficulty. He did not think that, as far as they could see, judging from the quality of the coke, there should be the slightest trouble in disposing of it; and he thought that, when they considered that from a ton of oil—and Mr. Young would tell them later on how many tons of shale this represented—they obtained 5 cwt. of coke, this was not a very large quantity to be left over. As Mr. Yuill had indicated, they must have some residue, unless they could introduce into their retorts some medium to carry forward the deposit of carbon which the gas was not capable of carrying with itself. He must say that, as far as the burning of the coke was concerned, he had, like Mr. Bell, of Dalkeith, tested the coke; and he could assure the meeting that it quite satisfied him. He had not the slightest difficulty in burning it; and, from what he had read and heard, this oil coke (or "still bottoms," as it was quoted in the market) had been a saleable commodity in the coal market of Glasgow for the last fifteen years, and was largely used for raising steam for yachts. It was compact, and possessed a high heating power; and it gave off no smoke. If they became manufacturers of the coke, supposing it should come to be a residual in their works, the price which they would receive for it—20s. per ton—would, he thought, recoup them, although they might have to stop the process for a month or two to get quit of the production. Then with regard to the spraying process, no doubt there was also a future in store for that. Mr. R. Herring, of Dover, had gone extensively into this subject, and had invented and patented very

complete plant for spraying oil.* No doubt most of them knew the plant, which was inexpensive and workable. There was no doubt that, when it came to be a question of enriching (say) 15-candle gas from common coal, possibly the spraying process might be found more useful or applicable to add one candle to the quality of the gas; but if they came to enrich 17-candle gas up to the Scotch standard of 26 candles, he questioned very much whether they should, or could, do this by spraying. He saw no difficulty in adding a candle or two to the illuminating power of a poor gas; but he was afraid spraying would be found incapable of raising it 9 or 10 candles. Mr. Young had replied to the question with regard to the testing of the oil gas. For the gas they obtained from a pure oil, to burn by itself, no burner had been invented; or rather there was no burner in existence that could consume 5 cubic feet of this oil gas in one hour. Consequently, the oil gas had to be diluted with coal gas before they could test it in the photometers as they were made at the present day. He did not know that he had anything further to add; and therefore he would call upon Mr. Young and Mr. Bell to reply to the different speakers.

Mr. YOUNG said he was very pleased indeed that a gentleman having so large an experience of the subject as Dr. Stevenson Macadam possessed, should agree with him on the general principles he had advanced relative to the production of illuminating gas from hydrocarbons. However, Dr. Macadam took exception to one of the principles—that of decomposing the oil frequently, in successive stages, instead of at one single operation; and he doubted whether, by the decomposition of the oil in this way, the same illuminating value, in the form of gaseous compounds, could be obtained from the oil distilled frequently. He gave as his reason for coming to such a conclusion that the quantity of carbon eliminated in the solid form by the process was in excess of what his past experience would lead him to believe was the case in decomposing oil at a single operation, and at high temperatures. There were two ways of taking the value of the result arising from the decomposition of oil during the process of gasifying it. Dr. Macadam had taken the weight of the carbon as the sole guide in coming to his conclusion regarding the process. He (Mr. Young) proposed to take, as the basis of his argument, the weight of gas obtained, and its specific gravity. It was

* An illustrated description of the appliance referred to will be found in the *Journal of Gas Lighting*, Vol. LX., p. 770.

somewhat difficult to get at the weight of coke and tar resulting from the process; but there was no difficulty in correctly measuring and taking the specific gravity of the resulting gas, and from these factors calculating out its total weight. He had looked over a great many analyses, giving the production of gas from various oils, by Dr. Macadam and others, which had been published in the Transactions of English Associations. He had carefully calculated out the weight of the gas obtained, and in no case was there a greater weight than 4¼ lbs. per gallon of oil. The difference between the weight of the gas obtained and the weight of the original oil from which the gas was produced must have gone somewhere. If it was not left behind in the retort, it must have assumed some different form elsewhere—probably soot and tar. By the Peebles process, however, the gas obtained per gallon of oil weighed from 6 to 6¼ lbs.; and the difference between that weight and the weight of the original oil was left in the retort as good hard coke—no tar whatever being made. These results had been very carefully verified; the volume and the specific gravity of the gas being accurately noted, and the coke as quenched was weighed, month after month, at the Peebles Gas-Works. Then, with regard to the high results referred to by Dr. Macadam as having been obtained from the decomposition of oil in previously existing apparatus, he had to remark that he had not the slightest doubt that such results could be obtained with a process of decomposing oil carried on under the careful supervision of one so skilled as Dr. Macadam. He did not think, however, that Dr. Macadam, or any other gentleman present, could point to a practical process, in the hands of ordinary workmen, by which such results could be achieved as those which had been obtained by the Peebles process in practice, and by which the oils could be wholly decomposed into such high-quality gas—leaving the carbon in the retort in the form of a good solid coke such as they saw before them. With regard to the difficulty likely to be experienced from the large amount of coke resulting from enriching gas by the Peebles process, instead of shale, it was not the quantity of coke produced from the oil to which Mr. MacPherson had referred, but that produced from the splint coal employed to make the poor gas to be enriched. Undoubtedly this would, in some cases, prove to be a trouble; but it should be also kept in mind that the coke from splint and similar coals was of a superior quality, and would command a market where cannel coke would not. There would certainly be no difficulty in disposing

of the coke resulting from the oil. In the paraffin oil industry, with which, as they were aware, he had been for a very long time connected, there was produced, in the process of refining oil, a very similar coke to that obtained by the Peebles gas process. Such coke was regularly stored up in the oil-works during the winter months, and sold at from 30s. to 35s. per ton for use in firing steam-yachts in the course of the summer. The next point that called for attention was the illuminating power of the oil gas obtained by the different processes alluded to. He had to remark that, even allowing that the same volume of a like quality of gas had been obtained in the past by other processes as that resulting from the Peebles system, it did not necessarily follow that these gases would have the same enriching value; for, as was now well known, the illuminating power of a gas resulting from the mixing of two illuminating gases, or of an illuminating and a non-illuminating gas, was not the mean of the illuminating power of the mixed gases, as would be indicated by simple calculation, but might deviate a considerable way, either above or below what calculation would indicate, dependent upon the interaction upon each other of the mixed gases. For instance, if they took marsh gas, they were aware that, by itself, it had an exceedingly low light-giving value. By careful "nursing," it might be made to have an illuminating power of (say) 5 candles. When, however, it was associated with a hydrocarbon gas having a high illuminating power, there was developed, by the interaction of the gases, an illuminating value far in excess of that which mere calculation would indicate; and he had no doubt that, by mixing gases having the same high illuminating power, their light-giving properties were derived from different classes of hydrocarbons. With marsh gas, although it might be mixed in exactly the same proportions, varying results would be obtained. Now, by cracking up the oils frequently, at comparatively low temperatures, in the way described, a different series of hydrocarbons was produced than when the same oil was cracked up all at once in one operation. Professor Lewes, who had made an analysis of the gases produced by the Peebles process, showed that the hydrocarbons present were principally olefines, and that only an exceedingly small quantity of the benzol group were present. On the other hand, it was well known that oil gas made at high temperatures owed a considerable part of its illuminating power to the benzol group; and he had little doubt that the difference in the constitution of the oil gas obtained by the Peebles process was the cause of its higher

value as an illuminating agent. The question had been asked whether it would not be more economical to carbonize the shale direct, instead of distilling it first for oil, and decomposing the oil into gas. There were a great many factors which came into play, and affected this question. In the first place, the shales that were used in the mineral oil industry contained a small quantity of bituminous matter, and yielded only from 20 to 30 gallons of oil per ton. This quantity of oil would give between 2000 and 3000 cubic feet of gas—gas, however, of an exceedingly high illuminating power. If the same shale were carbonized direct, it would produce double this volume of gas. But, owing to its bituminous constituents being decomposed in the presence of water vapour, as well as to other causes, the illuminating power would not be one-half of that obtained from the oil. In other words, the 2500 cubic feet of oil gas obtained by decomposing the oil would have a greater enriching value than the 5000 cubic feet resulting from the direct carbonizing of the shale. Then, again, the conditions obtaining in shale-oil works were different from those in gas-works. As a rule, the retorts used for the distillation of the shale were placed in the immediate vicinity of the mines; and, in the majority of cases, the shale raised from the mines was tipped from the hutches into the shale-breaker, and crushed to the desired size—an operation requiring no more labour than that which would be needed to load the waggons had it to be sent to a gas-works. From the breaker, the crushed shale was run on to the top of vertical retorts, into which it was tipped. In the upper part of these retorts, the shale was distilled at a low temperature for oil; and the resulting coke, or rather residue, thereafter dropped into the lower part of the retort, which was raised to a high heat. Then the residue was brought into contact with steam—the high temperature of the retort enabling the carbon present in the residue to decompose the steam into water gas; and as the carbon of the residue contained nitrogen in its constitution, there was produced a quantity of ammonia equivalent to from 20 to 40 lbs. of sulphate per ton of shale. The exhausted shale then dropped by gravity to the bottom of the retort, and was sent to the *débris* heap. The cost for labour in working the shale came to something like 9½d. per ton. Their friend Mr. West was able, with his arrangements, to perform the work of carbonizing coal at an exceedingly low cost; but he did not think he could do the whole of this work for 9½d. per ton of coal. It was also to be noticed that shale was a much more difficult thing to deal with than coal. He understood that Mr

West had had some practical evidence to this effect during the installation of his system in the gas-works at Aberdeen. He (Mr. Young) had no doubt that, in the majority of gas-works, it would probably cost three times as much to carbonize shale as it did in oil-works. Besides, it was further to be considered that the water gas coming from the decomposition of the steam by the carbon in the shale coke made, when cooled and freed from the accompanying water, an excellent fuel for heating the retorts. To supplement these gases, it only required from 0·75 to 1 cwt. of coal to carbonize a ton of shale; whereas the shale coke, or refuse, was of no use in gas-works. The shale required from 3 to 4 cwt. of coke from coal to carbonize it; and, instead of being a source of profit in the form of producing coal gas and ammonia, it was in many ways a source of nuisance in gas-works, and was costly to dispose of. The item of carriage was also a serious one. The carriage of shale from the mine to the gas-works might be taken to average 2s. 6d. per ton. Oil in tank-waggons was carried at rates rather lower than shale. It took 10 tons of shale to produce a ton of oil; and therefore, practically, with such shales as were used for oil-making, the carriage of shale to the gas-works would be ten times what it would be for oil. One tank-waggon of oil would convey as much gas-enriching material as ten waggons of shale. He thought what he had said disposed of this point. Reference had been made to the use of oil for enriching purposes, by injecting or spraying it into the retort during the process of carbonizing coal. He did not think this oil could be economically decomposed into gas under such conditions, as it was very liable to be under or over decomposed, dependent upon the rate of injection in relation to the condition of the coal in the retort. Besides, the decomposition must necessarily be effected in the presence of the water vapour coming from the coal, to the injurious effect of which he had already referred; and they all knew the great weight given by their friend Mr. Hislop, of Paisley, to the effect of water in coal-gas retorts during the distilling of coal, in deteriorating the results obtained. Both practical experience and the principles of the decomposition of oil would indicate that mineral oils could be much more economically converted into illuminating gas when they were decomposed by themselves, especially when the resulting gases were to be used for enriching purposes. Probably the next best process would be to decompose the oils in conjunction with water gas; and for some purposes, and in certain positions, it might be a preferable way. Water oil-gas processes might be regarded as a compromise

between principle and practice; for although not entirely consistent in principle, when there existed a small area within which to produce a large volume of gas, and especially when gas-producing plant which could be brought rapidly into operation (as in the case of a fog) was wanted, it might be advantageous to employ a water-gas process. The cost of crude material might also be such as to be equivalent to the defects belonging in principle to that process. He thought these were all the points to which it was necessary for him to refer.

The PRESIDENT said he thought they had had a very full discussion on the oil-gas question, and had thoroughly threshed it out. If they could carry it all away with them, he believed each would be able to take at least enough to keep him thinking for a good while. He mentioned that Mr. Bell had nothing to add to the discussion.

Mr. D. M. NELSON (Glasgow) then read the following paper:—

THE YEADON PROCESS OF GAS MANUFACTURE.

Throughout the entire range of apparatus employed in the manufacture of coal gas for illuminating purposes, there is no part of the process so important as the distillation and carbonizing department; for here it is that the gain or loss of the undertaking is determined. Yet, strange as it may appear, there have been fewer noteworthy improvements effected in the "retorting" of coal than upon any other portion of gas manufacture during the past thirty years. To tackle the mass of coal as ordinarily deposited in, and lying inert on the floor of the retort, lazily stewing into tars and liquors—involving enormous sacrifice of space and time, as well as waste of material—instead of passing off rapidly in a gaseous state, has hitherto defied the art of manual labour; while the skilfully designed machines intended to quicken the operation have been greatly baffled. Any process, therefore, which will effectually enable the external heat applied to the retort to permeate the charge, and so graduated as to accommodate any kind of coal, cannel, or shale, and extract therefrom the maximum quantity of permanent gas of the highest illuminating power these substances are capable of yielding, deserves a ready welcome from gas authorities.

Knowledge, if we may so term it, pertaining to the distillation of coal into gas is very much of the nature of speculative theory, and is difficult of definition; but the waste going on within the retort is none the less real, and fatal to the obtaining of good

results. Practically speaking, the gas-retort may be regarded as a sealed book, because of the hidden and complex character of its contents, and of the chemical changes which occur during the period, of from three to six hours, devoted to carbonizing. But in the abstract it is not difficult to infer that its full duty is far from being entirely developed, or that complete efficiency is not attained; for, as a matter of fact, the condition of the bye-products amply testifies that the ordinary systems of distilling into gas are carried on at serious waste and sacrifice of material —involving superlative mechanical power, and human fatigue out of all proportion to the benefits derived.

It is universally admitted that the primary duty of a gas-works manager is to manufacture *gas*, and to produce it *speedily*, saving time and labour; *largely*, yielding a profitable return; and of *good quality*, giving satisfaction to the user—not creating excess of tar, naphtha, and coke, and thereby contributing to the inevitable discomfort of over-production, and the self-inflicted damage and loss resulting from glutted markets. While the gas-retort may be termed the drudge of the household, it is also regarded, and very properly so, as the bread-winner of the family; and it is in this relationship that I desire to arrest your attention for a few minutes, as I describe to you a distinctly novel and the most efficient form of retort for economically and destructively distilling coal, cannel, or shale into gas that has ever been employed on a thoroughly practical scale, capable of being installed in any gas-works where the annual make exceeds 10 million cubic feet, while for a less quantity, it would of itself be capable of producing more than the maximum required, and, however employed, with an ease and comfort hitherto unknown to the anxious gas manager, free altogether from the slavish drudgery so common with the ordinary gas-ovens.

The Yeadon revolving gas-retort requires very small space—say, about 15 ft. by 10 ft. by 9 ft., or only one-eighth of the room occupied by ordinary carbonizing plant calculated to produce an equal quantity of gas—for instance, from 28 single fire-clay retorts set in four ovens, containing seven retorts each. It will be observed from the drawing that the space usually required for charging and drawing tools and machinery is saved; and when we consider the high—indeed, the too often exorbitant—prices paid for land near towns where gas-works are generally erected, coupled with the saving in the height of walls, and the superficial area of roofing, it will be seen at once that the gain is simply enormous when compared with the

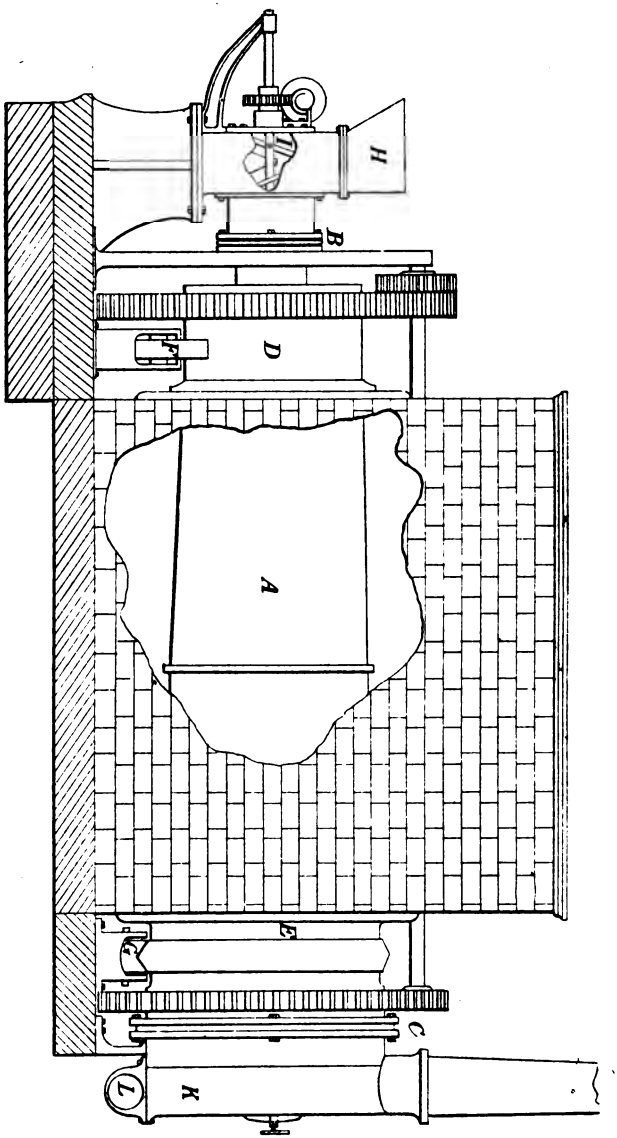


FIG. 7.—THE YEADON REVOLVING RETORT.

expenditure upon such buildings as are required for ordinary retort-benches.

As will be noticed from the drawing, the apparatus consists of a conical-shaped retort A, revolving on two gas-tight glands

(one at each end) B and C. The retort proper measures 8 ft. in length and 2 ft. 6 in. in diameter at the narrow end or back D, and 3 ft. 6 in. in diameter at the front end E. It revolves on four friction rollers F and G—two at the back and two at the front. The rollers marked F are square on the edge—giving freedom; while the rollers marked G are V-shaped, so as to keep that end of the retort in place, and assist the gas-tight gland C. By an arrangement at the back end in the gland B, the retort may expand longitudinally, which it does, but without interfering with the efficiency of that gland. At the inlet of the back end there is a hopper H, fitted with an archimedian screw (or knife-blades) I which conveys the coal into the retort. The interior of the retort is fitted with six taper blades or wings, which run parallel with the retort, and serve the purpose of breaking up and mixing the charge—an essential part of the process.

While revolving, the conical shape of the retort causes the charge to be gradually worked along to the front, or discharging end K (and it occupies only about twelve minutes in doing so), where the resulting coke or ash is passed through the exit-pipe L, into which is fitted an archimedian screw, similar to that at I, and thus delivers it into trucks, or sends it out directly to the coke-yard. At the back end of this pipe there is a jet of water, which constantly drenches the coke, and also prevents any escape of gas. Of course, there are the usual ascension-pipe and hydraulic main, which latter it is proposed to dispense with. The retort itself is made of iron, as are also the glands and all other parts; and the force required to cause it to revolve is 1-horse power nominal. This retort is capable of carbonizing from 12 to 15 tons of coal per 24 hours.

To save complication of figures, I have here a simple table showing the make of gas and its sperm value; the figures being the average of 24 separate tests on a practical working scale. In these experiments we used one ton of unscreened coal, and had 15,855 cubic feet of 22-candle power gas; showing an increase of 5551 cubic feet, and 5-candle power, over that obtained by the ordinary process with screened coal.

Ordinary Process.		*Yeadon Process.*	
Coal yields	10,700 c. ft.	Coal yields . . .	15,855 c. ft.
Sperm	408 grains.	Sperm	530·88 grains.
Sperm per ton. . .	623·65 lbs.	Sperm per ton . .	1203·44 lbs.
Illuminating power .	17 candles.	Illuminating power .	22 candles.

From these figures, any gas manager may easily calculate the gain such a retort would be to him in his working, even as an auxiliary. From *shale*, the increase is immensely greater and

more profitable. That subject will form interesting matter for another paper.

The resulting coke is of no worth as fuel, being incombustible; but is of equal money value, as it can be utilized for fire-proofing, and making a first-rate non-conducting cement, also for fine surface asphalting. The tar takes the form of a crude pitch; but while in the hydraulic main it has the consistency of a heavy tar, only assuming the form of pitch when exposed to the air. In the liquor-well will be found a small quantity of tar of a very light, watery nature, with practically all the hydrocarbons extracted. As to the ammoniacal liquor, it is only about half the usual strength, caused doubtless by being deprived of a large quantity of its illuminating gas before reaching the tar-well.

The gas made by this process is thoroughly permanent, as was proved last February, when we put 50,000 cubic feet of it into a holder, where it remained undisturbed for three weeks. On being tested at the end of that period, it was found to have lost only a quarter of a candle, and 20 cubic feet of its bulk—a loss so trifling as to be easily accounted for at that season of the year. Whatever is lost in tar, coke, and liquor, therefore, is more than compensated for by the increased quantity and quality of the gas, not to mention saving in labour.

As I have no desire to exhaust the subject, or to weary you by a lengthened reading (preferring rather to suggest inquiry such as may lead to discussion), I conclude by summarizing as follows: Being able to produce gas in 12 to 13 minutes is of infinite value during periods of fog and dull weather, and on the occurrence of mishaps or repairs, especially so when the demand for gaslight is sharp and excessive. The value of such an apparatus, capable of carbonizing any quality and kind of coal during a period of scarcity and difficulty in obtaining the ordinary supplies, will be manifest. By this process, the system of enriching poor gas by oil, &c., is rendered unnecessary; almost any coal being made to yield the desired illuminating power. There is no trouble from the deposit of carbon in the retort, or from choked ascension-pipes, the worry of gas managers. The enormous saving and convenience, in being able to heat up the retort in 4 instead of in 48 hours, as required by ordinary retort-ovens, is obvious. Sunday ordinary labour and night work are reduced by about 75 per cent.; while it will abolish overwork, and payment for overtime, also casual and foreign labour. All the foregoing advantages, and many others too numerous to detail here, are palpable gains,

and cannot be overvalued, either financially or socially, in the economy and utility of manufacturing gas.

Discussion.

The PRESIDENT intimated that Mr. David Terrace was an authority on the subject dealt with in the paper.

Mr. NELSON said his reason for not introducing Mr. Terrace's name was that experiments carried out by that gentleman and others were entirely independent of the process, and were made for the benefit of the gas industry; all the parties interested being banished from the premises.

Mr. D. TERRACE (Middlesbrough) remarked that, besides Mr. Nelson, he was the only one present who was acquainted with the process; and anything he had to say about it he had embodied in the paper which he read before the North of England Gas Managers' Association in April. But he was not able to get such results as Mr. Nelson had portrayed. The coal they used was Thrislington; and they obtained from it about 12,000 cubic feet of 18-candle gas, which was 2 candles more than they had in the ordinary way, and did not show any great enhancing value in the Yeadon process. Of course, he could recapitulate his own paper—in fact, Mr. Nelson only recapitulated it—in respect to the points of advantage in the Yeadon over the ordinary process. But until it was really practically at work, which the plant from which the results now before them were obtained was not (because Mr. Nelson referred to its exposure to the weather), it was impossible to say what it could do. There were certain things which had to be found out. This was quite a new apparatus, and would require to be thoroughly tested. He was going to mention the subject of coal analysis, in which it was wisely said that the conditions of the tests ought to be stated. If they could bring their results up to this, it would need very careful working. He had recently had a circular handed to him which said, "Believed to be correct, but not guaranteed." He took this to be owing to the favourable action of the Association on past analyses. It was rather strange that they should have the two processes in juxtaposition—the Peebles process and the Yeadon process. It was very evident there was something in the coal which they wanted to get out, and which they did not just now; and he trusted the two subjects they had had before them would spur them in the direction of enhancing the products of the coal in the ingredients they dealt in.

Mr. JOHN WEST (Manchester) said he had carried out some

experiments on the subject before the meeting. About 25 years ago, he thought, he made some trials with a little machine into which he dropped coal from a hopper. He had an ordinary clay retort, closed at either end. In that retort he spread the coal in an even layer on the bottom; and he certainly obtained some very large volumes of gas—from 12,000 to 13,000 cubic feet per ton of Newcastle coal. He had, as a product, a thin layer of a very light coke. He was certainly enraptured with the results; but, after an extended experience, he found that the fuel required was rather exorbitant. This was a question he would like to put to Mr. Nelson—as to the amount of fuel used per ton of coal carbonized by the Yeadon process. He found that he lost a great deal by the radiated heat; there being a large exposure of ironwork at either end of the retort. Of course, it was a very different system from the one before them; although it appeared to him there would be a little similarity. His retort was stationary. The volume of gas he obtained was very good, and of a permanent character. A number of his friends in the South saw it working; but after it had run for some time, he did not proceed with it, because he could not make it quite satisfy his friends in the matter of pounds, shillings, and pence. He spent a considerable amount of money on the process, and gained much information, which he stored up and applied in another direction He thought the Yeadon process was worthy of their consideration and trial. He believed in trying all these things, and ascertaining what they could get out of them. It was good for all of them, if they were to arrive at a right conclusion. He had not seen the Yeadon apparatus; and therefore he could not form an opinion as to its mechanical and economical efficiency. The temperature to which it was subjected would severely test it; but he thought they might take it that this retort had entered into the "region of practical politics," and that, as time went on, they might hear whether it had turned out good, bad, or indifferent.

Mr. J. Ballantyne (Rothesay) said he noticed that Mr. Nelson had not given them any information as to the cost of the process. If they were to get no better results than Mr. Terrace had obtained (and if there was no coke, how were they to heat the retort?), this would make the process very expensive. Perhaps Mr. Nelson could give them some information on this point.

Mr. J. B. Terrace (Brechin) remarked that one thought had occurred to him while listening to the paper before them, and that was why Mr. Nelson, who was a Scotsman, and lived among Scotch cannel, did not use some of their high-class cannel coal

in his retort. If he obtained such high results from a mixed or small coal, which ordinarily yielded 17-candle gas, and 22-candle gas with his Yeadon apparatus, they might get 60 or 80 candle power out of the first-class cannel they employed. With regard to the mechanism of the machine, he thought it was a very ingenious one. He saw that water always had to be poured upon it, to keep it cool. He thought, looking at it, that it was worth a fair test. He did not like to condemn anything before giving it a thorough trial; and not only one, but many trials.

The PRESIDENT said he did not know that he could add anything to the discussion further than the remarks he made in his address. But he thought no one, looking at the drawing and the results, could question for a single moment that there was really something in the Yeadon retort. A revolving retort was not a new thing, though it certainly was new as far as gas making was concerned. Revolving retorts, however, were used in other processes; and a retort which he had himself seen working in some of the Cornish mines, for roasting tin and copper ores, was not unlike the one before them. The calciner there was set on a level plane, and the fire travelled through the tube. Of course, in making gas, they must keep the flame outside the retort. This had been accomplished; and by tapering the retort, they secured the motion or travel of the material. He thought the secret of the Yeadon retort was that the coal was treated in the same way as oil in Mr. Young's process. Mr. Young had been successful in cracking the oil in very small particles; and the patentee of the Yeadon retort had succeeded, in a manner, in cracking up the coal in the same way, in very small particles. He should like to ask Mr. Nelson if he experienced any difficulty in keeping up the proper heat of the retort—in keeping it continuously working (say) for a week at a time; and also whether there was any difficulty in getting the coke to come out. There was one good feature of the retort, and that was that there were no moving parts inside it. Various methods had been tried; but, as far as he could see, it was impossible to get any material that would stand the temperature at which they had to carbonize coal—from 1800° to 2000° Fahr. The great advantage of the retort was, he thought, its capability of treating dross and small shale. There were enormous piles of this, as they saw when travelling over the country. In times of strikes, it might be a question whether the Yeadon retort could not be profitably employed in working up these vast heaps of refuse. He would like to ask Mr. Nelson one other question. He could easily suppose that, by cracking up the coal in the

Yeadon retort, it would be quite possible to get 15,000 cubic feet of gas from a ton; but he could not understand the last line of the table. He could easily see how an extra quantity of gas could be obtained; but the additional candle power seemed to be difficult to accept. He was sure Mr. Nelson could explain this; but he had overlooked it.

Mr. NELSON, in replying, expressed his obligations to the various speakers for their criticisms of his paper. He said his friend Mr. Terrace had stated that he had tried in the retort a coal that was recognized in Yorkshire to be the toughest and most disagreeable for gas managers to work. They adopted the plan of using a coal that was largely employed in gas-works in Yorkshire farther south than Middlesbrough. They used Aldwarke Main coal. This was a very much higher type of coal than the Thrislington which Mr. Terrace dealt with. He mentioned this to explain why Mr. Terrace did not get anything like parallel results. They found that the better the quality of the coal they worked with, the higher were the results they obtained. For instance, they had used shale; and they had an immensely increased result. They then tried cannel; and they also had an increase that was quite enormous. He might likewise state that they sent up from one of the shale heaps in Scotland a waggon-load of shale, which yielded 6000 cubic feet of 24-candle gas. At the present time these heaps of shale were an absolute waste, cumbering the ground; and the officials of one of the oil companies in Scotland had said they would be very glad if they could have theirs removed. It was necessary they should understand that there was no discrepancy between the remarks of Mr. Terrace and his own; for the simple reason that coal of a different character was experimented with. On this account, he might say that the illuminating power they obtained from working the coal was derived from the large proportion of naphthas, benzols, and other properties of the coal they turned into gas. No naphthas or light oils were found in the tar-well. There was nothing but ammoniacal liquor. With reference to Mr. West's remarks, he might say that the heat was so low at the port, that they could put their hand upon it; and the heat bearing upon the retorts was only applied to about 5 feet of it. It differed from an oil or any other retort in the fact that it did not buckle or blister. Because of its revolving, there was no unequal draw upon it; and the heat was equal. The retort, which had been in use for two years and a half, was as smooth on the surface now as on the day it was put in. With reference to Mr. Ballantyne's remark as to the want of fuel,

such as coke, they had an arrangement by which they heated the retort by its own gas, on the Bunsen principle. They had found that the gaseous fuel was better than Leeds coke. The expense would be greater, in the exposed position in which the retort was, than if they had fitted it in a confined space. He might say, however, with regard to the question of cost, that he made a calculation, which showed that something like 50,000 cubic feet of gas could be put into the holder at 6¼d. per 1000 cubic feet. Assuming that they did this, instead of having four ovens of seven retorts, each producing gas, they could make a calculation of the one as against the other. With reference to the price paid for the apparatus, it was rather less—£700, perhaps, as against £800 for retort building and other apparatus, and the structural portions required for the retort-house. All the difference between this apparatus and the experiments which had gone before was that in the Yeadon process there was no heat to warp the fittings. There was no difficulty whatever in keeping up the heat. In point of fact, they found that it was less variable by the Yeadon process than it was in ordinary retorts; and as to the ejection of the coke, he might tell them that it came out just like sand—there was no congestion and no difficulty was experienced in its falling out. With reference to the bearings, he might say that the water spoken of had nothing to do with the bearings. It was not used to keep them cool; it was to quench the coke, and it helped to seal the gas and prevent it escaping.

Mr. J. BALLANTYNE (Rothesay) next read the following paper:—

COOKING BY GAS.

Cooking by gas is a subject which has not received at our meetings that attention which it deserves. So far as I have been able to find, it is exactly ten years—in 1883—since a paper (and it seems to be the only one which has been written on the subject) was read at the Stirling meeting, by Mr. J. M'Crae, the respected Engineer of the works belonging to the city in which we are now met. He again touched on it in 1885, in his presidential address of that year to the Association. Since that time, no reference seems to have been made to it at any of our meetings—certainly not at any of those at which I have had the pleasure of being present. It is therefore owing to this silence on the subject that I have been induced to take up the matter, so as to again bring it under your notice, and also record the success which has attended its introduction into Scotland during the last ten or twelve years—a success which, I am sure, is as

great as Mr. M'Crae ever anticipated when he wrote his paper in 1883.

Dundee, I believe, has also the honour of being the first place in Scotland to adopt the system of hiring-out cookers and other similar appliances to the gas consumers. This was, I think, in the year 1881; and it is no doubt owing to the example then shown that we owe the success of that system. Previous to its introduction into Dundee, it had been adopted in a large number of English towns; yet we Scotsmen, owing no doubt to our proverbial "canniness," were slow to take advantage of the experience of our brethren across the Border, until Dundee led the way. Of course, we of the smaller works naturally expect our larger neighbours to lead the van in new enterprises and experiments, as a few hundred pounds spent in this way is a small matter to an important undertaking, whereas it would be a very serious thing to a small one were the experiment to turn out unsuccessful. But we are always glad to follow the example set us, especially when we think it a good one; and hiring-out gas cookers was certainly a step in the right direction. Had it not been for this new outlet for our gas, I am afraid many of our works would not be in that healthy and flourishing condition in which we now find them. I therefore desire to call your attention shortly to the advantages of encouraging, in every possible way, the system of cooking by gas. Much of what I have to say will not be new to many of those who have already adopted the system of hiring out gas cookers; but I trust it may be of some interest and use to those who have not as yet done anything in the way of hiring them out. There are still many places where I am sure the system would be a success if adopted.

The gas cookers of to-day are possibly as near perfection as they can be; at least, so far as the heat to be obtained from the gas consumed is concerned. There may yet be slight alterations in the details of their construction; but it is questionable if much more can be added to their efficiency. As the heaters of the future have yet to be made, I do not intend to make any reference to them, but will confine my remarks solely to cooking by gas.

Every gas manager has here a large field which he can work, if so disposed, and a field which, I am persuaded, if properly wrought, will be found to be one of the best paying he can possibly get. In the first place, it does not require any extra plant to work it, as the consumption is principally during the day. To meet an increased night consumption means with most of

us an addition to our plant, as very few works can boast of ample provision in this respect. On the other hand, no extra plant will be required with an augmented day consumption until it exceeds that of the night—a not very probable thing for many years to come. Again, the employment of gas for cooking purposes is principally during the summer months, when the largest proportion of our plant is lying idle, although it will be found that, when once consumers begin to use cookers, they will do so, more or less, all the year through, but not to the same extent during winter as in summer, when the weather is hot. In Rothesay we have many consumers who use nothing but gas for cooking all the year round, as they find it cheaper than coal for the purpose, and, of course, very much cleaner. During the months of May and June, and part of July, our day consumption is as great now as that of the night. This means an increase in the daily make, during that period, of almost 100 per cent.

We began to hire-out gas cookers in 1886; and since then our annual make of gas has increased from 22,127,700 cubic feet in that year to 32,741,400 cubic feet in 1892—being an advance of 48 per cent. For the six years prior to 1886, the increase was only about 9¼ per cent., as the annual make of gas in 1880 was 20,249,600 cubic feet. Or if we take the revenue from consumers by meter alone, we find that for the year 1886 it amounted to £3392, with the price of gas at 4s. 7d. per 1000 feet, less 10 per cent. discount, if paid within twenty-one days; whereas in 1892, with the gas charged at 3s. 9d. per 1000 feet, less 5 and 10 per cent. discounts if paid within a month, the amount was £4235, or an increase of £843, notwithstanding the reduction in price. Fully 11 per cent. of our consumers are now supplied on hire with cookers or ranges, hot-plates, and oven fittings; and, we calculate that, on an average, each cooker or hot-plate is equal to at least £5 per annum of revenue for gas consumed. For cookers we charge 10 per cent. on the list price; and for hot-plates and oven fittings, 6s. per annum—all fitted up free. I am safe in saying that, were it not for the hiring-out of gas cookers, the increase during the last six years would not have exceeded 7 or 8, instead of 48 per cent., and probably less; as for two years preceding the introduction of cookers into Rothesay there was actually a decrease in the quantity of gas produced. And when we take into account the enormous advance which has been made in the construction of oil-lamps, as well as the great extension of lighting by oil, especially among the better classes, we could hardly expect that

the same rate of increase could have been kept up during those six years, as compared with the previous six years. We have also to take into account that all public-houses have been closing an hour sooner than usual; and should the earlier closing of shops become general, there will be a still further reduction in the quantity of gas required for lighting purposes. It thus behoves us to find as many new outlets for our gas as possible, so that our progress may be ever onward. It is a bad sign when the make of gas shows a steady drop year after year, as it means, with declining revenue, less profits.

But it may be asked, Is it a safe investment to engage in the hiring-out of gas cookers? Will it not be the case that, after a few years, we shall have them all thrown on our hands as old iron, and that the cooks and housewives will go back to their good old-fashioned coal fires? I firmly believe that so long as gas is to be had by which to cook, there will be a demand for gas cookers. The form of the cooker may change somewhat, and that can be very little now; but there is no fear of cooking by gas becoming obsolete till that far-off day which has been pictured for us by some of our friends (?), when there will not be a bit of coal left the wide world over by which either to make gas or kindle a fire. Cooking by coal fires is much more likely to be a thing of the past than cooking by gas. In truth, with many it is a thing of the past already. And is it not a fact, patent to everyone, that gas-stoves are becoming more popular every day? There need, therefore, be no fear of getting them back as old iron, till they have been completely worn out in good service. In my own case, I have not a single gas cooker that is not in use, and earning its 10 per cent.; and, further, I have not a single obsolete cooker belonging to the Corporation. True, a few of the older forms have been made more modern, by having newer designs of burners fixed in them; but these do not exceed a dozen cookers in all. Any handy man can easily put in new burners at very little expense.

As to repairs, I do not know what has been the experience of others, but I have found it to be a very small item indeed. With the exception of those cookers, already referred to, which received new burners (and, strictly speaking, this was not a repair, but an alteration), and a few odd frets for the grills, we have had very little expense for repairs during the six years we have hired-out cookers. The cleaning of cookers, after receiving them back from customers, is the most expensive item we have as yet had in connection with them. Apart from this, our outlay for repairs will not much exceed 1 per cent.

Most of the cookers returned are sent in to us in the autumn and winter months, and we clean them at odd times when we have not much else for our men to do; and this keeps them working when they might otherwise be idle or doing very little.

If a corporation or a company wish to make cooking by gas a success, they must fix the cookers free of charge. Man's faith, after all, is very weak; and few of our consumers have enough, at first, to enter into any expense in regard to a thing of which they may know little or nothing. At any rate, their faith in cooking by gas may not be sufficiently strong to enable them to lay out probably from 20s. to 40s. for fixing up a cooker. Our general system of renting houses by the year is also against them doing it at their own expense. A tenant never knows how long or how short a time he may occupy a house; and as he may have to leave it at the year's end, this is a great drawback to him hiring a gas cooker, and paying for fixing it up. But if the corporation or the company fix the cookers free of charge, he will probably be only too glad to take advantage of the arrangement, and hire a cooker. Again, should a tenant fix up a cooker at his own cost, when he wished to leave the house, he might have to sacrifice all the expense to which he had been put, as it might not be convenient for him to have the cooker in the place to which he would afterwards remove. On the other hand, with a corporation or a company fixing up the cookers at their expense, the cooker and all the tubing and fittings can be taken away when a tenant removes, with the loss of only a union coupling, costing from 3d. to 4d., and the fitter's time. For this reason, no tubing but that of block tin should be employed, unless you are certain the tenant will occupy the house and keep your cooker for a great length of time, in which case composition tubing may be put in. As, however, we are sure of nothing in this world, and know not what a day or an hour may bring forth, you should use block tin, which can be removed and utilized again time after time. Even when it is no longer fit for use, it can be melted down and sold, when it will bring nearly as much as was at first paid for it. Besides, after all, there is very little difference in price between block tin and composition, when we take into account the weight of each. We have, as a rule, always used block tin at Rothesay; and it has been our experience that, in the end, it is very much the cheaper material of the two.

Further (and my remarks now refer more especially to smaller works), all who can afford to keep a fitter, should try and employ one who can do the fitting necessary in putting in gas cookers;

so that you may be able to undertake the fixing of them yourselves. When this is done, the expense is very much reduced. Our average price for fixing them ourselves does not exceed 12s. 6d. each, including the flue. That is allowing for—

	s.	d.
Block tin tubing, 30 feet (say)	7	6
Flue for oven of cookers	1	6
Coupling and hooks	0	6
Time—Fitter, 5 hours, 2s. 6d.; labourer, 1½ hours, 6d. .	3	0
	12	6

We find in our case 30 feet to be about the average length of tubing employed but this will greatly depend upon where the meters are situated, as in most cases it is necessary to lead the pipe from the meter. If they are at the front door, with the kitchen at the back of the house, or in some equally out-of-the-way place, where meters are generally put, the expense may be a little greater; but, taking it all through, it should not much exceed what I have stated. It is therefore not a great sum, when we consider that the piping can all be taken away again, as already indicated, with only the loss of time and a coupling.

In towns where gas-fitters have shown some energy in introducing and pushing the sale of gas cookers, it would be unfair to take the fitting from them. But, unfortunately, such cases are not many; and an arrangement could be made to divide the work among them, or even to give it altogether to the man who had been pushing the trade. As a rule, gas-fitters have left the gas-stove business "severely alone;" and in their case there can be no hardship in a corporation or a company fixing the stoves themselves. If a corporation or a company are entitled to hire-out cookers, they are equally entitled to fit them up at the least expense. At Rothesay we leave the sale and fixing of gas heaters entirely to the gas-fitters, as well as all grillers, Bunsen burners, &c.

Gas cookers should be as simple as possible in construction and working; and I would recommend those made of enamel sheets, both inside and outside; as they are very much lighter and more easily handled, and can now be had at the same price as those made of cast iron. They also look better, and are kept clean with less trouble. It comes to be a serious question, especially in small works, when three or four men may be required to carry a heavy cast-iron cooker up a flight of stairs in a tenement house; whereas, in the case of those of lighter make, the fitter and his assistant should be quite sufficient for the work. Those made of enamel sheets will last as long as

there is any need for them; and by the time they are used up, they will have repaid themselves, by hire alone, a good many times over. A corporation or a company will be quite justified, therefore, when the stoves are worn out, in replacing them by new ones. We do not require an article that will last for ever, but one that will last a reasonable time, and possess all the advantages possible.

We also find that, on an average, from 5 to 7 per cent. of our cookers are returned to us, and in most cases through the consumers either leaving town or removing to a different house where they are not required. In a very few cases, through the extravagance and carelessness of servants, resulting in large bills, we have had cookers returned to us by consumers, on account of being too expensive; but we have also found that, after a short time, they have invariably come back, asking for another one, as the ordinary fire was found too hard to work after their experience of gas. To encourage our consumers to keep their cookers after once getting them, and not to ask for them to be exchanged for other sizes or makes, it is a question if we should not have some graduated scale of charges, instead of the 10 per cent. I should be inclined to charge 10 per cent. for the first three years only that a consumer has had a cooker without any change, 7½ per cent. for the following two or three years, and (say) 5 per cent. afterwards. Or, if this should be thought too complicated, charge 10 per cent. for the first five years, and 5 per cent. afterwards. This would, no doubt, considerably reduce our returns for hire of cookers; but the longer we can get our consumers to keep their stoves without changing them, the better for us. To remove a cooker from a house, and fix that of another maker, because Mrs. So-and-So next door has it, is a thing we should try to discourage as much as possible. Time is occupied in sending out another cooker, and taking away the one in use; and when a stove has been brought away, it requires cleaning before it can be again employed, all of which means a considerable amount in wages. I therefore think it would be an advantage for us to forego a little of the rental, and induce consumers to keep their stoves after once getting them. This does not apply so much to towns where only one make of cooker is in use; but there are not many of us who hire-out cookers who are so fortunate as to be in this position.

It is a great advantage to have in use cookers of as few makers as possible. Those who are just beginning to let them on hire should study this, and fix on the best make in the market, and keep to it, and not allow any other form to be hired out

It will save a great deal of trouble afterwards. We have no fewer than five different makers' cookers in use at Rothesay; and we have found this to be a disadvantage in the way referred to. Those who are placed in this position would, I believe, find that the reduction on the rental would, as already mentioned, be an inducement to consumers to keep their cookers. And, further, where only one make of cooker is hired out, as there is always some change taking place in the construction of these appliances, the consumer would think twice, where the graduated scale of charges is in operation, before parting with his cooker for any supposed improvements which might be in the newer forms. An extra column in the stove ledger, containing the date when the cooker was fixed, is all that would be necessary to prevent confusion in the charges. That is the objection which has been raised to it in our own case, or I believe it would have been adopted by this time; but I yet expect to see it introduced, and before very long. If we recovered our expenses from the hire of the cookers—and the graduated scale indicated would enable us to do this, and leave a margin besides—it is about all we should look for; and we should trust to the extra sale of gas for our profits or their equivalent. This is really where the advantage of the system rests—not in the rental returns, but in the extra consumption of gas.

And now a word in closing with regard to differential rates for gas consumed for other than lighting purposes. We do not charge differential rates for gas consumed for either cooking or heating; but we allow discounts of 5 and 10 per cent. on all accounts, if paid within a month after the date of rendering. This, of course, comes to much the same thing as a differential rate, in so far as it concerns consumers who are not able to pay within the prescribed time. It has been urged against differential rates that they are unfair, and place the night consumer at a disadvantage as compared with the day one. In other words, the man who can afford to pay for a gas cooker gets his gas for culinary purposes cheaper than his poorer brother, who can only afford to burn it at night for lighting his house. But the same objection holds good with regard to discounts for payment within a given time, as it also places at a disadvantage the poor man, who has not the money at hand with which to pay his bill within the specified period. These objections, however, may be more imaginary than real, as the poor man must remember that, if he does not pay within the allotted time, he generally causes more expense to the corporation or the gas company in collecting his account. The day consumer does

not necessitate any extra outlay for holders, mains, or even service-pipes; but, on the contrary, he is utilizing plant while it would otherwise be lying idle, and for this reason he is entitled to some consideration. The night consumer will also reap the advantage of cheaper gas, although he does not get it at the same rate as the day consumer; for the larger the make of gas is, the greater will be the profits, and consequently the gas will be sold more cheaply on that account. The principal objection to a differential rate is that it requires an additional meter, so as to arrive at the correct quantity used. This means an extra outlay of capital. But in towns where a charge for the use of the meter is made, it will not matter so much, if the consumer is willing to pay it. In all cases, as far as practicable, the differential rate meter should be subsidiary to the primary one; and it may be placed alongside of it. No extra service from the main, however, should be put in, unless it happens to be cheaper or easier to do it in that way than to take the supply from the outlet of the meter already in use. It would be a great mistake to riddle our mains with holes for gas-cooker services or any other appliances which might only be in use for a short time. It would also help to increase the leakage area—a thing very much to be avoided. At Rothesay we prefer the discount system, as it is easier and cheaper to work. Graduated discounts on (say) £5 a year and upwards could be allowed. This will save the further outlay of capital for meters; it will relieve the consumers from paying an additional rental for the meters, in towns where these charges are made; and it will obviate a great deal of extra book-keeping, which is necessary where differential rates are in use. The discount system also helps to make consumers pay their bills more promptly. But at the same time I see no objection to differential rates, where they are preferred. The discount would affect everyone whose account reached a certain sum. The differential rate would only apply to those who used gas for a given purpose, whether the sum were large or small. In this way a person using probably only 20s. worth of gas would get it at a cheaper rate than the consumer who might burn £50 worth; so that another hardship comes in there. But these apparent difficulties should not be allowed to stand in the way of making gas more useful and popular. It is only by finding new outlets for our gas that we can hope to hold our own against the competitors now in the field. One thing is certain, that, should the electric light become the light of the future (as it no doubt will, to a certain extent, in course of time), those towns

which have been fostering cooking and heating by gas will come out of the struggle with least loss. In our own case, suppose we lost the whole 20 million cubic feet of gas now required for lighting purposes, we should still require to manufacture at least 12 millions for our gas-stoves. This, then, is the weapon with which to fight the electric light. If this branch of our business were pushed as it might be, we need have no fear of seeing the electric light introduced, because all that would be more than regained by the gas required for cooking and heating purposes.

I have tried—very imperfectly, I know—to place before you the advantages of encouraging the use of gas for cooking; and as it has done more than anything else, during recent years, to increase the consumption of gas in those places where it has been so used, I trust the various points noticed, as well as others not referred to, will now be freely discussed. With even such a simple matter as cooking by gas, and hiring-out appliances for the purpose, we require all the information it is possible to obtain; and we know that, "in the multitude of counsellors, there is safety."

Owing to want of time, discussion on this paper was postponed till the next meeting.

The following paper, by Mr. GILBERT LITTLE, of London and Aberdeen, was taken as read:—

AUTOMATIC APPLIANCES FOR SMALL GAS-WORKS.

Carlyle, who defined the highest point of mechanical genius as "the power to bring together two forces which fit each other and give birth to a third," characterized the two decades, 1850-1870, as the mechanical age—"the age of labour-saving machinery in every form; an age which, with its whole undivided might, practises the great art of adapting means to ends. For the most intricate, as well as for the simplest operations, the same abbreviating processes are in readiness; there is no end to the triumphs of self-acting machinery." There is a true Carlylean flow of exaggeration in the foregoing quotation. We are a good distance yet from the perfection in labour-saving machinery depicted by the "Sage of Chelsea," particularly in gas-works; but greater activity in this direction may be looked for, as in the setting-out and management of new, or in the improvement of old, retort-houses. The object now chiefly kept in view (under the disadvantages of an almost daily disturbed state of the labour market) is the need of automatic

appliances to manipulate the coal and coke. This has been particularly noticeable in most of the recent extensions and improvements in large gas-works, the engineers and managers of which appear to be fully alive to the fact that no investment yields so high a return as machinery skilfully employed. A few of the more enterprising chiefs of large gas-works are evidently proceeding on the principle of the old Lancashire saying, that it is always worth investing £1000 to save the annual cost of one man's labour.

Since I prepared the paper on "Transit of Materials in Gas-Works," for your meeting at Perth in 1890, my Company has equipped a considerable number of gas-works with our automatic coal and coke handling machinery; but, so far, our operations have been confined to large, or fairly large, works. I am therefore unable to give you details of the working of automatic appliances in small works. But the custom in the engineering profession is to try new appliances on a small scale; and, when the experiment is successful, the shrewd and capable engineer proceeds to carry out the improvement throughout his works. This has been the course followed by gas engineers in introducing coal-handling machinery in connection with inclined retorts; so that, although I am not provided with the *data* for this paper regarding installations of automatic appliances in small works, I am able to put before you the particulars of installations which were small plants in large works. The experimental settings tried at Southall, Birmingham, Rochdale, Burnley, Coventry, Leigh, Oxford, and Middlesbrough contained from one to five beds, or five to thirty retorts; and the coal-handling plant consisted simply of the automatic appliances necessary for a small retort-house.

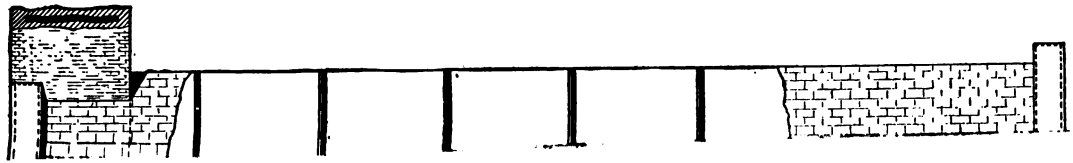
The two years subsequent to my last appearance before you (1890 and 1891) were principally devoted to supplying and erecting appliances for small experimental installations; while 1892 and 1893 have seen the extension and completion of large automatic retort-houses on the new principle.

It would occupy too much time to refer in detail to the automatic appliances erected in connection with all the small or experimental installations; so I confine myself to one—viz., Middlesbrough—and the *modus operandi* which obtained there will serve to indicate generally the methods followed at the other works. I select Middlesbrough because Mr. Terrace, the Engineer and Manager there, was so long "one of yourselves;" and although, like Jock o' Hazeldean, "o'er the border and awa'," he is still more a Scot than any "Mac" on the N.B. roll

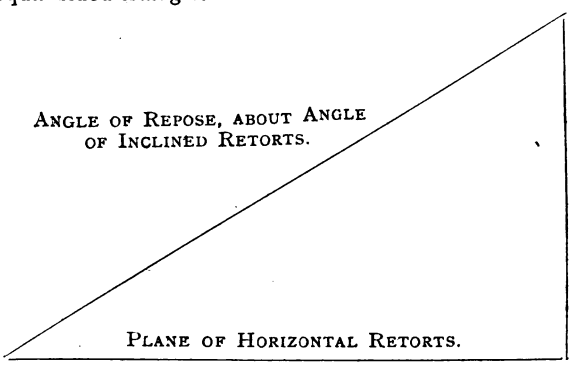
DIAGRAMS ILLUSTRATING MR. GILBERT LITTLE'S PAPER

ON

"AUTOMATIC APPLIANCES FOR SMALL GAS-WORKS."



embership (*vide* the North of England men). It must be fying to his numerous friends north of the Tweed to observe not only was the paper he read last month at Belfast the ect of unstinted praise, but it very visibly disturbed the phets who had, at former meetings of The Gas Institute, gnosticated that the "inclines" would, after a sickly infancy, into a rapid decline. As the new system has got quickly r the defects in details common to the introduction of all v processes, and has gained so many champions, it is safe to nclude that there is a future for the principle of charging gas-orts by gravitation. Still, I need not indicate a preference any system; as it is now palpable to all that, whether clined, revolving, or horizontal retorts with mechanical argers are used, coal breakers, elevators, conveyors, and ppers are indispensable auxiliaries. But it strikes me that ie natural sequence is that the law of gravitation should be ken advantage of to the full as the coal gravitates from the oppers. With which of the systems can this be best attained? he answer can be made very plain by the aid of a scalene or nequal-sided triangle.



From a given point (the bottom of the hoppers) the law of gravitation can be utilized to slide the coal down the hypothenuse of the triangle; but to get the coal along the base after it drops down the perpendicular side, mechanical force must be applied. So in charging the "inclines," the coal falls from the hoppers through the portable shoots; and the momentum thus acquired spreads it over the retorts, in the way other materials gravitate down an incline equal to the hypothenuse of the triangle. In the case of the "horizontals" the coal drops like any material falling down the perpendicular side, and is then scooped or pushed by the mechanical

chargers into the retorts, set on the same plane as the base of the triangle. This having been made luminous by Mr. Terrace in his paper, followed by Mr. Winstanley's neat and needed reminder regarding the years consumed in "coaxing mechanical chargers," the "scooping school" has been fluttered into a concerted condemnation of "inclines," in which the liberty of lamentation proper to perturbed prophets is prominent. If "rotary" or any form of "continuous" carbonizing has a future, conveyors and elevators will play an important part.

In the paper which Mr. Terrace read before the members of The Gas Institute at Belfast, he confined his remarks on the machinery (as you would notice from the very effectively illustrated article which appeared in the *Journal of Gas Lighting*) to the extended coal and coke handling plant, as arranged for the whole of the retort-house; so I do not go on old ground in referring to the automatic appliances he used to charge the retorts of the experimental settings. The arrangement was as follows: An elevator was fixed, so that the coal could be tippe . from the waggons into a receiving hopper over the elevator-boot. Over the elevator-boot a pair of crushing rolls was fixed, to reduce the coal to the desired size. The coal, on passing through the rolls, dropped into the elevator, and was lifted to a receiving hopper fixed above the top mouthpieces of the inclined retorts. The coal was delivered through the doors in the bottom of this hopper into a portable truck, which held the charge for the retorts. This experimental plant at Middlesbrough formed practically a small retort-house automatically equipped. In the extended plant (as you would all gather from Mr. Terrace's paper, aided by the very elaborate illustrations reproduced in the *Journal* from the Middlesbrough drawings), the extensions have been arranged by Mr. Terrace with little of that nervous timidity which upsets so many men when they leave the "beaten track." No; having made sure of the general principles in his experimental plant, Mr. Terrace can now trust them implicitly, and he has wisely carried them out in a way in which the first cost of the new system and the automatic appliances are considered of far less importance than any diminution in efficiency.

This feeling I find prevails almost universally among the gas engineers who aspire to lead the van of progress in the introduction of automatic appliances in gas-works. In the manufacture of the automatic machinery, improvements have been made by "leaps and bounds," through close heed having

been given to the hints and wants of those gas engineers who have improved the modes of handling coal and coke, so that the work is now rendered practically labourless. The complete mechanical manipulation of the coal, from the time it is discharged from the waggons or barges until it is delivered as coke to the yard or waggons, is now attained in modern equipped retort-houses of large size; and perhaps one of the most complete so far in England is that at Leigh, which is a medium-sized gas-works, where, in addition to an up-to-date automatic retort-house, Mr. Fletcher, the Engineer and Manager, has arranged a self-acting plant, which carries the coke from the retort-house direct to the storeage hoppers, from which the trucks and carts are filled automatically. But the question I am confronted with almost daily is, "Can a similar state of efficiency be attained with a paying saving in labour by using automatic appliances in small gas-works?" and my most persistent interrogator has been your President, Mr. Douglas Hall—his interrogations at last taking the shape of a command to prepare a reply, and convey it to the members of this Association in a paper.

Well, from the experience gained in the working of the small plants in large works, I could safely answer with a simple affirmative, as all engineers (including Mr. Maurice Graham, the Engineer to the Automatic Coal-Gas Retort Company, who use our appliances on the settings worked under their patents) are convinced that, without conveyors and elevators to manipulate the coal, a saving in labour cannot be effected in retort-houses. But, with the hope of making my "Yes" somewhat emphatic, I have prepared illustrations, showing automatic appliances arranged in a small retort-house with inclined retorts.

From the illustrations you will notice that the retort-house with inclined retorts has three beds of seven retorts. The coal falls into the hopper over the coal-breaker, and is lifted by the elevator to a steel-chain or steel-rope push-plate conveyor with a special form of cast-iron trough, which distributes the coal into the storeage hopper arranged over the top mouthpieces of the retorts. Under the storeage hoppers the measuring chambers are fixed, to hold a charge for each tier of retorts; and from these the charge for the retorts is conducted through the portable shoots. This plant is driven by an engine with a 6-inch cylinder; and the driving arrangement is very simple. The engine is connected to the small vertical shaft which communicates the motion to the short countershaft. On this countershaft two sprocket wheels are fixed, to drive the elevato

and conveyor, by means of a detachable compressed-steel chain. The cost of the machinery, including engine, coal breaker, elevator, conveyor, storeage hoppers, measuring chambers, portable shoots, and accessories, would be about £450 erected.

I have limited the illustrations to an arrangement for inclined retorts; but almost the same quantity of automatic appliances would be required to deal with three beds of ordinary horizontal retorts stoked by manual-charging machines. The engine, coal breaker, and elevator would be the same for horizontal retorts as for the "inclines;" and the difference would consist in having the storeage hoppers fixed in front, to fill the manual charging-scoops. We have two plants of automatic conveyors and elevators in operation at the works of the Lancaster Wagon Company, Limited, in connection with two ranges of gas-producers; and the machinery is almost identical with what I have outlined as necessary for small retort-houses with inclined or horizontal retorts. The two arrangements of automatic appliances at Lancaster are so satisfactory that we have the order to supply the machinery for a third range; and I am empowered to state that Mr. Shackleford, the Managing Director of the Lancaster Wagon Company, will be pleased to allow any member of this Association to inspect the automatic systems in operation.

The automatic plants I have outlined, for inclined or ordinary retorts, could be arranged with a self-acting coal-store, having a conveyor delivering the coal into the hopper over the coal-breaker. A new retort-house with twenty beds, designed by Mr. T. B. Ball, of Rochdale, has been arranged with an automatic coal-store having two conveyors in the bottom, one 80 feet and one 110 feet long, conveying the coal from any point in the store to the two coal-breakers. The automatic coal-store is not an experiment, as it is on exactly similar lines to the self-filling and self-emptying coal storeage plants which we have erected within the last four years for Messrs. Guinness, of Dublin, Sir W. Armstrong, Mitchell, and Co., of Newcastle, and over a hundred hardly less well-known firms.

The machinery for both the horizontal and inclined retorts would only require to be run about two hours during the day-shift to fill the hopper for the day and night supply. The breaker, elevator, and conveyor are driven by our new patent compressed-steel detachable chain, which is the best transmitter of power in gas or dusty works.

The great progress made during the last four years with automatic conveyors and elevators to manipulate the coal used in

gas-works is apparently to be followed by similar activity in the installation of like self-acting machinery to deal with the coke. Already the "thin end of the wedge" has been introduced; and small experimental installations have been tried. The first coke-elevator we supplied for a gas-works was for an arrangement designed by Mr. Baker, of Reading. This elevator lifts the coke from the yard to a coke-breaker. The broken coke is screened into four or five sizes, and falls by gravity into the sacks arranged to receive the different grades. This "elevator" is a combination of the ordinary bucket elevator and tray conveyor, and is known as the "tray-bucket elevator." Mr. Terrace inspected the coke-elevator at Reading before he entrusted my Company with the contract for the coke-elevator at Middlesbrough. Another small coke-elevating plant has been supplied to the order of Mr. James Eldridge, of Oxford. This is arranged to fill the railway trucks automatically. The slaked coke is shot from the barrows into the elevator, which is set at an angle of about 45° and parallel with the railway. The coke is delivered by this tray-bucket elevator to a short tray-conveyor, which trims it into the railway waggons. This is a small experimental plant to test the machinery thoroughly, with a view to the adoption of an extensive automatic coke-handling system in a new retort-house now in course of construction at Oxford. Mr. Winstanley, of Coventry, has also arranged a coke conveying and elevating plant; but this is too extensive to come under treatment in a paper on "automatic appliances for small works."

I have purposely refrained from referring to the details of systems of conveyors and elevators to deal with anthracene, sulphate, &c.; as plant of this class is not of immediate interest to managers of small works. But I may state, for the benefit of the members who will doubtless obtain the management of larger works, that our automatic arrangements for anthracene, sulphate, and other chemicals could hardly work better.

Permit me to add, in conclusion, that through the experience gained during the last twelve years in introducing numerous contrivances to shorten processes, and cheapen the cost of handling all kinds of materials, particularly coal, coke, lime, and oxide, we have succeeded in devising labour-saving tools which enable us to manufacture automatic appliances as suitable, efficient, and durable for small gas-works, as the similar apparatus for large installations; and I confidently expect to see the commendable enterprise displayed by several of the gas engineers of large corporations emulated by those having

charge of small works, so that the workmen in both large and small retort-houses will soon become merely the attendants on machinery, producing results, with swiftness and accuracy, vastly superior to hand labour.

Election of Office-Bearers.

The President intimated that the scrutiny of the voting-papers had resulted in the election of the following as office-bearers :—

President.—J. M'Gilchrist, Dumbarton.

Vice-Presidents.—A. Wilson, Dawsholm, Glasgow; A. Yuill, Alloa.

Secretary and Treasurer.—Robert S. Carlow, Arbroath.

Members of Committee.—A. MacPherson, Kirkcaldy; John M'Crae, Dundee; and A. Bell, sen., Dalkeith.

Auditor.—R. B. Main, Glasgow.

Mr. M'Gilchrist returned thanks for his appointment to the office of President.

Place of Next Meeting.

Next year's meeting was fixed to be held in Glasgow.

The Question-Box.

There was only one paper in the Question-Box; and the President ruled that it was not necessary to answer it.

Votes of Thanks, Etc.

On the motion of the President, a vote of thanks was accorded to the readers of papers.

Mr. MacPherson then presented the medal of the Association to the President; and Mr. Hall accepted and acknowledged it in suitable terms.

Mr. R. Mitchell (Edinburgh) proposed a vote of thanks to the Secretary, Mr. Carlow, who returned thanks.

The President proposed a vote of thanks to Principal Peterson, of the University College, for allowing the Association to meet in the building—a privilege which, he said, had never been accorded to any other body.

The meeting then closed.

The members and their friends afterwards dined together in the Queen's Hotel, nnder the presidency of Mr. Hall, and with Mr. M'Gilchrist and Mr. Yuill as Croupiers. Lord Provost Matthewson and Mr. J. Mitchell, the Convener of the Finance Committee of the Dundee Gas Commissioners, were present.

Visit to the Dundee Gas-Works.

During the interval for luncheon, the members were driven to the Dundee Gas-Works, where Mr. J. Mitchell, the Convener of the Finance Committee of the Gas Commission, received them. Under the leadership of Mr. M'Crae, they walked through theworks; paying particular attention to the new sulphate of ammonia plant, and the arrangement which Mr. M'Crae has fitted up for the firing of his steam-boilers with tar, and which was working very satisfactorily. The exhauster-room, containing four exhausters driven by steam, was admired as a model of neatness. At the close of the inspection, luncheon was served in one of the store-rooms, after which the President, speaking in the name of the Association, thanked the Gas Commissioners for their kindness in affording the members the opportunity of seeing the magnificent gas-works of the Corporation, and also for their hospitality. Mr. Mitchell, in response, expressed the pleasure they had in entertaining the Association. He had, he said, the honour of proposing Mr. M'Crae when he was an applicant for the post of Engineer and Manager of the gas-works; and he was glad to say that his proposal was unanimously accepted. This was a step of which he was proud; for Mr. M'Crae had given the utmost satisfaction to the Commissioners in his management of the undertaking.

NORTH OF IRELAND ASSOCIATION

ANNUAL MEETING, AUG. 8.

This Meeting was held in the Hall of the Café, Coleraine—Mr. W. S. STORMONTH, Engineer and Manager of the Coleraine Gas-Works (the President) in the chair.

A WELCOME TO THE ASSOCIATION.

The PRESIDENT having briefly opened the proceedings,

The HON. SECRETARY and TREASURER (Mr. J. Whimster) read a letter from Mr. R. A. Taylor, Chairman of the Coleraine Town Commissioners, expressing regret that previous arrangements had deprived him of the pleasure of meeting the Association, and bidding them welcome to Coleraine. He said he looked upon these gatherings as being of great importance, giving to the several managers of gas-works throughout the country the advantage of what was most valuable to them—exchanging views, throwing out suggestions, and noting improvements. He referred in appreciative terms to the skilful management of the gas-works by Mr. Stormonth.

ANNUAL REPORT.

The SECRETARY next submitted the annual report of the Committee, as follows:—

The Committee have pleasure in announcing such an attractive programme for the Coleraine meeting. The Vice-President's paper and Mr. Macadam's lecture both bear upon the manufacture of gas from oil, which may be said to be the burning question of the day amongst gas engineers; and the paper by Mr. Main, deals with a subject which has a most important bearing on the future prospects of all gas companies. At the same time, the Committee cannot but express their regret that our ordinary members should seem so backward in contributing papers for our annual meetings. Whilst aware that most of our members represent small gas-works, they think that this fact should encourage, rather than deter them from contributing the results of their experience in the various departments of their work; as, though a record of their successes or failures may seem commonplace to themselves, yet it would doubtless be exceedingly useful and instructive to their fellow-members.

The resolutions recently adopted by the South-West of England

District Association, with reference to a scheme for the federation of the District Associations, were communicated to your Committee; and they resolved to bring them before this annual meeting, and recommend the appointment of representatives to the conference on the subject shortly to be held in London.

The Committee have taken a new departure this year, in organizing an excursion for the day following the business meeting, in the hope that the gathering may partake more of a social nature; and they trust that their action will be endorsed in a large attendance of the members and their lady friends—especially as the locality to be visited is so noted and interesting as the Giant's Causeway.

Your Committee debated the question of altering the date of the annual meeting, which was remitted to them for consideration; but they could not see their way to recommend any other date as more suitable than the one originally adopted.

According to Rules 25 and 26, three Members of Committee retire now, and are ineligible for immediate re-election. The retiring members are Messrs. Salmon, Todhunter, and Walker.

(Signed) W. S. STORMONTH, President.
JAMES WHIMSTER, Secretary.

Accompanying the report was the financial statement, which was also read by Mr. Whimster.

On the motion of Mr. E. STEARS (Lisburn), seconded by Mr. R. Ross (Dungannon), the report and statement of accounts were unanimously adopted.

THE PROPOSED FEDERATION OF GAS ASSOCIATIONS.

A letter was next read from the Secretary of the South-West of England District Association of Gas Managers (Mr. Norton H. Humphrys, of Salisbury), submitting the two resolutions on the above subject passed at the meeting of that Association on the 11th of April (see *ante*, p. 70), and requesting that the matter might be brought before the North of Ireland Association.

Mr. T. FRIZELLE (Holywood) agreed with the decision which had been arrived at by the Committee, and moved that the matter be allowed to remain in their hands.

Mr. G. CUMMINGS (Ballymoney) seconded the motion, which was agreed to.

ADMISSION OF NEW MEMBERS.

On the motion of the SECRETARY, seconded by Mr. A. MACKENZIE (Edinburgh), the following new members were elected: Mr. T. Llewellyn (Newbridge, Co. Kildare), Mr. R. Gault (Aughnacloy), and Mr. T. M. Walsh (Kilrush).

On the motion of Mr. FRIZELLE, seconded by Mr. Ross, Mr. J. R. Noble (Belfast) was elected an extraordinary member.

Election of Office-Bearers.

The Secretary intimated that the Committee wished to propose Mr. C. B. Outon, of Inchicore, Dublin, as President for the ensuing year.

This was agreed to *nem. con.*

Mr. Outon thanked the members for the honour they had conferred upon him.

The Secretary then stated that the Committee considered that they could not do better than submit to the meeting the name of Mr. P. J. Salmon, of Galway, for Vice-President.

This was adopted unanimously.

The meeting next elected, as successors to the three members of Committee who were retiring, Mr. T. Hands (Enniskillen), Mr. G. R. Love (Dundalk), and Mr. C. B. Tully (Sligo).

Mr. Whimster was again elected Hon. Sec. and Treasurer.

Place of Meeting for 1894.

The President intimated that the next item on the *agenda* was the selection of the place of meeting for next year.

The Secretary remarked that this matter had also been considered. Their newly-elected President resided in Dublin; but the Association met in that city last year, and Armagh had therefore been agreed upon.

Mr. Outon moved that Armagh be the place of next meeting.

Mr. Mackenzie seconded the motion, and it was adopted.

The President's Address.

The President then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—Before touching on any of the topics to which I propose to briefly make reference on this occasion, allow me to thank you for the honour which you have conferred upon me in asking me to take the chair to-day. As you are aware, our esteemed friend Mr. D. M'Callum, of Omagh, who was to have presided over our deliberations in Dublin last year, was unfortunately unable to do so; and, as Vice-President of the Association, it devolved upon me to take his place. It is very gratifying to me to be, for the second time, in this position; and I trust that, with your kind forbearance, I may be able to discharge to your satisfaction the duties which are expected from your President.

I must confess, at the outset, that it is an exceedingly difficult thing to speak to you in a manner worthy of the

occasion, or to supply you with mental food for digestion; for the reason that, not only in England but in Scotland, there are so many kindred Associations to which addresses are delivered and papers read, that it is well nigh impossible to find anything fresh to discourse upon. But, while making this admission, I must at the same time point out that the conditions under which gas is made in Ireland and those which obtain on the other side of the Channel, are vastly dissimilar. The managers of gas-works in Ireland have exceedingly limited constituencies, with perhaps three or four exceptions. We cannot, therefore, put ourselves on a level with our English and Scottish *confrères*. The comparatively limited extent of the works and capital of the gas industry in Ireland does not permit of research on any extensive scale. I am by no means trying to under-estimate the difficulties which beset the Irish gas manager. I wish merely to point out that his opportunities of contributing, in any very important degree, to the advancement of the mechanical or commercial departments of the industry, are necessarily circumscribed. At the same time, I am bound to confess that the management of gas undertakings in this country is not so easy a task as one unfamiliar with the precise conditions under which they are conducted would be apt to imagine. Although, in the majority of instances, we have to deal with a limited constituency, we have to satisfy the public with light; and we have to earn for our shareholders or for the ratepayers, as the case may be, a fair return on the capital employed.

A manager who has only five or six retorts in use in summer, and perhaps only from twelve to eighteen during the period of his maximum supply, may well stand aghast when he hears of gas-works in which one day's manufacture would supply his consumers for six to ten years. Striking though this comparison may appear, it simply means that larger plant has to be employed, with a larger staff of workmen. The man who has the control of these vast undertakings has, no doubt, great responsibilities in seeing that his subordinates perform their duties. But, on the other hand, he is relieved from those cankering cares and petty annoyances which are the daily experience of the manager who has not only to personally attend to his limited number of retorts, but also to read meters, collect accounts, and look after every detail connected with the business. Having all these duties to perform, I maintain that the manager of small works, such as predominate in Ireland, has infinitely more trouble than one situated in a large town, with the command of a large undertaking. These observations,

however, are merely commonplaces, though I fear that on this occasion I have very little else to offer you.

Looking around us, we can see that there has been something approaching a revolution in gas manufacture. Originally we had the iron retort, which held sway for a very long period, and which, even yet, has its advocates in various parts of the United Kingdom. But it has been almost entirely supplanted by the clay retort. We have had learned papers and discussions on the proper temperature at which to distil coal, as well as a flood of literature on the subject of gas purification, and the subsequent treatment of the tar and ammoniacal liquor; and in all these directions improvements have been, and are still being, made. In a number of cases we have gone from the horizontal to the inclined retort; and we have abandoned manual and adopted mechanical labour. Much of that hand labour, which is a very serious item in the cost of gas, has been dispensed with, and in its place there have been introduced mechanical contrivances, ingenious in their construction and practical in their application, all tending to keep the price of gas at the lowest possible figure.

This brings me to a subject which, even in small works, must play a very important part. As you are all aware, in order to maintain the standard of luminosity which is demanded in Ireland, as in every other part of the United Kingdom, it has hitherto been found necessary to employ a certain percentage of high-class coal or cannel. From that cannel we obtain (say) from 10,000 to 13,000 cubic feet of from 28 to 30 candle gas. The cost of a ton of the material required to produce that high-quality gas has to be seriously considered by all gas managers. Within the last eight years, we have had water gas (which for illuminating purposes must be carburetted) brought under our notice. We have had various patents taken out for such carburation; and a question which every gas manager who supplies gas of high quality has to consider, is whether he shall continue to use cannel to carburet the poor gas which he obtains from ordinary coal, use a better class of coal, or introduce plant to enrich by means of water gas carburetted by oil gas, or by means of oil gas alone. A ton of cannel and a ton of oil cost exactly the same for carriage, yet the one substance will give double the quantity of gas of high luminosity that the other will. The Lowe water-gas plant has been successfully worked in London, and it is now being adopted in Belfast; but, so far, we have had no experience of it in a small works. There is, however, a probability that we shall soon have a statement of

experiences from one of our own members, whose output is about 20 million cubic feet per annum. It appears that, owing to short holder accommodation, he has difficulty in supplying the demand on Saturday nights, which naturally causes a good deal of trouble and anxiety. To meet the difficulty, it is contemplated to erect a carburetted water-gas plant; my friend thinking it better to spend £400 on this plant than £3000 on a new holder.

The two processes which have most largely attracted attention in recent times are the Lewes, patented by that very eminent chemist Professor Vivian B. Lewes—whose paper on enriching coal gas many of us had the pleasure of listening to at the recent meeting of The Gas Institute in Belfast*—and the Peebles, identified with the name of Mr. William Young, who has done yeoman service, not only in the distillation of shale for the production of oil, but in the destructive distillation of coal for the production of gas. Mr. Young has identified himself with two Gas Associations in Scotland—the West of Scotland Association of Gas Managers, which is now extinct, and to a great extent with the North British Association of Gas Managers, at whose meeting the other day I observe that he read a paper upon "The Principles of the Production of Illuminating Gas from Liquid Hydrocarbons."† I have not seen in operation either of the two processes to which I refer; and consequently I cannot pronounce an opinion as to which will obtain most favour. But it seems to me, judging from the papers which have been read on the subject, and from the discussions to which they have given rise, that Mr. Young's method is more adapted than that of Professor Lewes to the wants of small works. In the event of a sudden demand for light, by reason of fog, Professor Lewes's system would better meet the necessities of the case—that is to say, where storeage accommodation is deficient. It is simple and quick in its action; it gives, within reasonable bounds, a gas of any required luminosity; and it appears to me that the necessary plant cannot be very expensive. On the other hand, where bright weather prevails, Mr. Young's process is more likely to obtain favour. The plant, as in the other case, is inexpensive; there is a minimum of loss in what may be called the fractional distillation of the oil employed; there is an enormous gain in luminosity

* See *Journal of Gas Lighting*, Vol. LXI., p. 1150.

† See *ante*, p. 152. For Messrs. Young and Beil's specification, see *Journal of Gas Lighting*, Vol. LXII., p. 169.

and it is in the power of the gas manager to regulate that luminosity to any desired standard. The plant is easily erected, and is not liable to get out of order; and so far as I can judge, the process must play a very important part in the future of gas undertakings, more particularly in small works producing a high-quality gas.

On looking over the paper by Professor Lewes in connection with this process, and the discussion thereon at the recent Institute meeting in Belfast, there appears to be some discrepancy in the various statements, on which, perhaps, further light may be thrown by the papers we are to be favoured with to-day. Professor Lewes says: "In using the Young gas as an enricher, special precautions will have to be taken to ensure perfect admixture with the gas to be enriched. The richness of the gas means that it has a very high specific gravity; and although, theoretically, diffusion should make it possible to produce a perfect mixture of light and heavy gases in a holder, yet in practice every gas manager knows the tendency which variations in specific gravity have to bring about 'layering' in the holder, and to cause considerable variation in the quality of the gas sent out." In answer to this, one of the speakers says that in Peebles, during the summer, gas of 17 candles was made for 24 hours, and then a quantity of oil gas was mixed with it; and there was no difficulty in keeping the quality perfectly regular. This appears to me most remarkable. It must be assumed that the supply to the town is never turned off; and how by working in this manner the gas supply can be kept at a regular quality seems odd, and not in accordance with practice. Take the common method of manufacture, working into and supplying out of one holder. If the retorts are not charged, half the total number at work at a time and at regular intervals, it will be found, even in that short time, that the supply will be variable in quality.

Another question raised in connection with the process was the use of tar instead of oil; one speaker indicating, as the outcome of observation at Peebles, that satisfactory results can be obtained from tar—"beautiful gas and capital coke." Making gas from tar is not new. At the present time it is carried on with conspicuous success in at least one town in England; but the same process has been tried in other towns, and found not to work satisfactorily. Why it should prove successful in one place and not in another, is difficult to understand. One of our members who has tried the process promised to give us an account of his experience; but that promise has, unfortunately,

not yet been redeemed. Perhaps he may be induced to relate them on some future occasion, for the benefit of his fellows; as it often happens that more is learned from experiments that have resulted in failure than from those ending in success. The gasification of tar is of great importance to all gas managers at the present time; and it is to be hoped that we may acquire further knowledge of the subject ere long, as this residual is with most of us a drug in the market, especially where gas-works are far removed from centres of chemical industry. At present the only remedy is to burn the surplus stock; but even then the most that can be realized for it, indirectly, does not exceed 1½d. per gallon.

The Peebles process has, as yet, been adopted only in Scotch works; the chief reason for this being that gas of a high quality —from 25 to 30 candles—has hitherto been supplied in that country. To make this quality necessitates the use of first-class cannels; indeed, in a large number of cases, nothing but cannel was used for many years. Good cannel is, and has been for some time, selling at a price far beyond its value as an enricher; and this renders it necessary to adopt one of two courses—either to lower the illuminating power or to raise the price of gas. The latter course has in many cases been resorted to. The former is very unpopular in Scotland. The public there are used to gas of very high quality; and, according to the advocates of high quality, they "won't be happy till they get it." But it is a moot point whether the game of keeping up a high standard is worth the candle; or, in other words, whether the public get anything like the full lighting value made. As things stand, however, it would appear that Scotch managers must use cannel or enrich by means of oil. The Young process has opportunity here; for there is no doubt that it can enrich to a high degree at a price that will compare favourably with enrichment by cannel.

It seems strange to me that what is considered good gas in England and Ireland is looked upon as inferior in Scotland. Where 17 to 20 candle power is supplied, the public are satisfied. As a matter of fact, 18-candle gas is considered good in England and Ireland; and even in many towns where this is not reached, grumbling is practically unknown. The quality of gas in Ireland, and particularly in the North, averages from 17 to 20 candles. To supply this, English coal and cannel were used for a considerable time; but when these ran up in price simultaneously, a substitute was found in first-class Scotch caking coals. Four or five years ago, there was little of this

latter description of coal used in Ireland. But last year, I am informed, there were upwards of 100,000 tons carbonized; and this year the quantity will be even larger. There is not much reason for wonder in this, as the price is no higher than that of English coal; and with it a 19-candle standard can easily be maintained without the use of cannel. Such is my own experience for four years; and I am sure that with others it has been similar. When it is further considered that half the cost of coal is covered by the sale of residuals, it does not appear that the Young process of enrichment can be of much practical or economical benefit to us, at least so long as the coals referred to can be had at a moderate price.

There is still another system of enriching, to which attention has not been very prominently directed, and with respect to which I should like to say a few words. I refer to the hydro-oxy gas process. This has been in operation in London; and, as it is not very well known, I need not apologize for giving you a short description of it. The gas is obtained by retorting mineral oil at low temperatures, and mixing with the resulting non-permanent oil gas, while it is still warm, about 30 to 50 per cent. of oxygen. It is said that, by this process, the lighting capacity of the original oil gas is much increased, and a permanent gas of very high illuminating power is obtained. It is, moreover, claimed for it that the low temperature prevents the deposition of carbon, and renders possible the use of crude, residual, and low-priced oils, in place of the refined and high-priced ones now employed. I have not had the opportunity of seeing this process in operation; but a friend has, and he assures me that, when this enriching gas is mixed with the ordinary product supplied in London, the result, in the way of additional light, is marvellous. I believe plant has been erected at Huddersfield to give the process a trial; and we shall wait with interest the report, which will doubtless be published by Mr. Herring, upon the outcome of his operations.

The use of inclined retorts is extending, although there are differences of opinion as to the advantages and economy attending them. Last year I had the privilege of inspecting a bench of inclined retorts. The stoking was conducted quickly, and with comparative comfort to the men employed. Drawing and charging were performed with a very perceptible absence of fatigue to the men, as compared with what is invariably associated with horizontal retorts and hand-labour. In a neighbouring works charging and drawing horizontal retorts was done by machinery, and, without doubt, in a very expeditious manner.

The settings were on the regenerative principle, the heats being very high; and, notwithstanding 6-inch ascension-pipes being fitted to every retort, "chokes" were the order of the day. So frequent were the stoppages, that it appeared to me that the comfort gained by the men in working the machinery was more than counterbalanced by the extra labour entailed in clearing the pipes, and the waste consequent upon opening the lids so often. On inquiry into the cause of the stoppages, I observed that the charges were very light for the size of retorts in use. This, combined with the high heats, was, I believe, the cause o the difficulty. In the retorts the gas is exposed to a species of roasting. Perhaps the best part of the illuminants is decomposed; and the carbon accumulates in the pipes. This exactly coincides with my own experience. Some years ago the experiment was tried of running four-hour charges with Lancashire coal. Retorts hitherto carbonizing a little over 2½ cwt. in six hours, were charged with a little less than 1¾ cwt., working off in four hours. The results were satisfactory for two or three weeks; but after that a most uncomfortable time was experienced. There was hardly a pipe in the retort-house that did not choke at least once every charge. The coal was the same, and there appeared to be no change in the heats; the only difference being four-hour small charges, instead of six-hour usual-sized charges. When the stoppages began, we endeavoured to battle with them for about a week; but, on the old system being reverted to, the trouble gradually disappeared, and was soon a thing of the past.

In this country, where the best lime is to be found, the question of purification does not trouble us much. When I say this, I do not wish it to be inferred that we produce gas and send it to our customers full of impurities. I mean that, by the use of lime, we abstract from the gas, not only the sulphuretted hydrogen, but the carbonic acid with which it is impregnated; obtaining for our spent lime, in many instances, a handsome return, so that the cost of purification per 1000 cubic feet is not a serious consideration. We hear however of new processes, such as the Claus, which is in practical operation at only one works—namely, at Belfast. We have all heard, also, of the Weldon Mud process;* and many of us, no doubt, use oxide of iron. All in this room are aware that Ireland supplies not only the best quicklime, but the best bog ore for purification purposes. I shall not, however, dwell on

* See *Journal of Gas Lighting*, Vol. LXI., p. 924.

take no trouble to educate the public in the advantages attendant on the use of gas for heating and cooking purposes. Any efforts made to educate the public in this matter will be amply repaid by increased business and larger profits. On former occasions, I have had the privilege of relating the details of our experience in Coleraine in this department. The results have, on the whole, been satisfactory—the increased output enabling, in a great measure, the Commissioners to reduce the price of gas from 5s. to 4s. 2d., and recently to 3s. 9d., with 5 and 10 per cent. discounts; and there is no doubt that the lowering of the price will have a further appreciable effect on the sales. Although we have done fairly well, a good deal more can yet be accomplished; but how best to do it is a matter for consideration. After all the exhibitions and cookery demonstrations we have had, fully three-fourths of the houses are still without gas appliances.

I have sometimes thought that the gas companies in a district should combine, and co-operate with local schools in establishing regular cookery classes; and that they should engage competent lady lecturers to travel from town to town giving lessons in the schools, and in private houses as well. The cost might be defrayed by the association of any number of the local gas companies. I believe the project could be made to work well and satisfactorily. I may say that in Coleraine we are at the present time endeavouring to make some arrangement with one of the local schools; but the expense seems too high for the school. If the managers can only be got to recognize the importance—indeed, the necessity—of teaching cookery in the schools, we may yet have the benefit of a resident lady cook. In introducing stoves, too much is left to the manufacturers. A great deal is expected of them; and the fact is often ignored that the benefits to be derived from holding exhibitions are mutual. The gas suppliers must enter heartily and actively into the matter; otherwise the public may think that stoves are simply made to sell, and thus defeat the object in view.

In the way of pushing business, a leaf might be taken from the book of the paraffin-oil dealers. Good lamps are sold at an extremely low price; oil is retailed by the pennyworth from door to door; and oil-stoves are frequently found at work, with their characteristic and offensive odour. From time to time we hear of fatal accidents attributed to the use of "cheap lamps;" but it is open to question whether the real cause is not cheap oil, which gives off vapour at a low temperature. The law is such that oils having a flashing-point of 73° Fahr. can be stored

and sold; and the bulk of American oil imported gives off vapour at a point little above this. In this country the temperature of the atmosphere is often over 80° Fahr.; and in lamps burning in houses it is considerably more. It is, therefore, not a matter for surprise that lamp accidents are so frequent. The public are ignorant of the danger of using these cheap oils; but are the public to blame entirely? I think not. In a climate such as ours, it is reasonable to assume that 73° Fahr. flashing oil is not safe; still it is sold, and the powers that be authorize the sale. Only oil having a much higher flashing-point should be supplied; and the sooner a change is made, rendering it illegal to sell what is known to be a most dangerous commodity, the better.

Notwithstanding the competition of oil, candles, and the electric light, gas still holds the field. The demand grows larger year after year all over the kingdom. Ten years ago, as shown by the parliamentary returns relating to gas undertakings, £50,250,000 was employed as capital in gas-works, and 7¼ million tons of coal were carbonized annually. Every year there is a large increase. The statistics for 1891-92 show that £63,500,000 of capital was employed; and 11¼ million tons of coal were carbonized. These figures illustrate the gigantic dimensions which gas manufacture and supply have now reached in the United Kingdom; and they point more clearly than any argument to the fact that gas is still the favoured illuminant. To advance its popularity and improve its supply is the aim of each and every one of us; and our assembling here to-day will, I hope, lead to increased energy, and so add—though it may be in a small degree—to the prosperity of the great industry with which we are identified.

During the past year the several Associations connected with the gas industry have done a vast amount of useful work; and I am in hopes that to-day will show our own contribution to the total to be no insignificant one. Individually, the societies have, by their work, justified their existence. Now there is a proposal on foot to bring the ten independent Associations into one great federation. The lines upon which it is proposed to effect this have not yet been formulated. But as a conference upon the subject is called for next month, to be held in London, we shall, no doubt, have further information on an early date. Without expressing any definite opinion one way or the other, I cannot resist saying that a very casual consideration of the subject leads to the conclusion that the federation now desired was practically in existence until a few years ago;

and the thought naturally arises whether, seeing it has failed once, it can be expected to be more successful in the future. But this is matter for further consideration; and at present I maintain an open mind upon it.

And now, in conclusion, a word about our own Association. Although we cannot congratulate ourselves on an increase of members, there is every reason for saying that the objects for which the Association was formed are being accomplished. It is a matter of regret that our Southern brethren are yet holding aloof. Perhaps the title "North of Ireland Association" still remains the stumbling-block. If so, the sooner it is changed the better. If the title is not the reason why Southern managers do not join, what is it? Surely they are not waiting for that promised and happy day when the "union of hearts" is to be an accomplished fact. I hope that some steps will shortly be taken with a view to having a thoroughly representative body of Irish gas managers. Although we have done good work in the past, I believe that, if our bounds were extended, the benefits derived, both professionally and socially, would be very much greater. When attending the last meeting of The Gas Institute, in Belfast, I could not but remark that the South of Ireland took a very prominent part in the proceedings, which were so ably conducted by Mr. Denny Lane. When the South can do so well abroad, it is reasonable to hope they may yet consider it their natural duty to lend a helping hand at home.

On the motion of Mr. Ross, seconded by Mr. E. STEARS, a hearty vote of thanks was passed to the President for his interesting and instructive address.

The PRESIDENT briefly acknowledged the compliment.

READING OF PAPERS.

Mr. C. B. OUTON (Inchicore, Dublin) then read the following paper:—

DESCRIPTION OF A NEW OIL-GAS WORKS ERECTED AT THE INCHICORE WORKS, DUBLIN.

It has occurred to the writer that a description of a recently-erected oil-gas works may possess some few points of interest to those members of the Association who do not happen to have had any practice in this particular branch of gas manufacture, as applied to railway-carriage lighting.

Although the oil-gas system has been in general use on many railways in Great Britain, it has only been introduced, up to the present, on three Irish lines. It need hardly be stated that the plant is intended to supersede the present system of lighting

produced by the indifferent mineral-oil lamps, and also their attendant heavy cost of renewals, breaking of glass bowls, and irregularity of burning. Bearing in mind the great improvements made in Irish rolling-stock in recent years, it is somewhat surprising to find that the lighting arrangements are still so much behind the times.

Like other gas undertakings, oil gas has a competitor in the electric light; and it is a significant fact that, after several years' trial on two or three English railways, the latter has been displaced in favour of oil gas. It may be inferred that the system of charging accumulators from a stationary dynamo, or charging them from a dynamo situated in the guard's van, driven direct from one of the axles, is far from being economical or satisfactory, except perhaps under certain conditions.

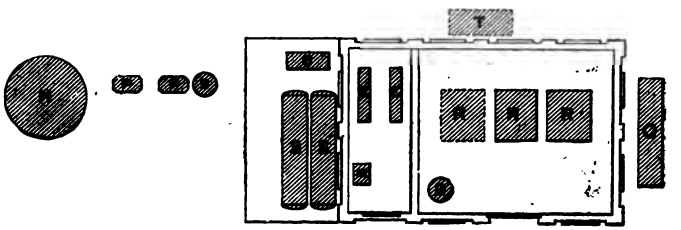
Coal gas is still being employed on a very few lines, notably on the North London Railway, where the recent introduction of a new regenerative lamp gives a light amply sufficient for all reading purposes, and is a great improvement on the old lamps fitted with flat-flame burners. The use of coal gas, however, is restricted to short journeys, owing to the larger storeage room required, and the necessity for frequent charging. This question of storeage forces itself upon the attention of the carriage designer, who has to bear in mind that a large portion of the available space below the carriage under-frame is already occupied by various brake reservoirs, rods, and other gear. It is chiefly due to the high illuminating power of oil gas, with consequent small consumption per burner, that its employment has become so general, and also to the fact that it may be readily compressed to 150 or 160 lbs. pressure, without any very great decrease of luminosity.

Cannel gas has been occasionally employed, and, no doubt, would form an efficient alternative; but the present enhanced price of this coal somewhat prohibits its use.

The oil-gas plant completed at the Inchicore Works, Dublin, for the use of the Great Southern and Western Railway, has been erected under the general superintendence of Mr. H. A. Ivatt, the Locomotive Engineer. It may be premised that this plant resembles, in many respects, those already in full work in England; but, in point of compactness of arrangement and combination, it presents a few new features which may prove interesting to those accustomed to similar undertakings. A general plan is here shown.

The oil, or "gas oil," as it is termed (which is supplied by the Pumpherston Oil Company), is stored in a tank, holding

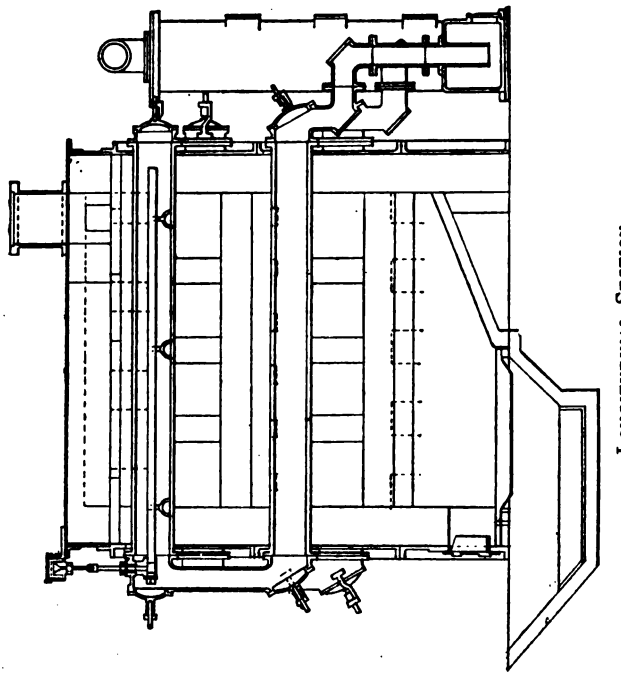
2000 gallons. It is a mixture of paraffins and olefines (having a specific gravity of ·840 to ·850, and a flash-point of 220° Fahr.); and it is obtained by the distillation of shale. The oil is elevated by means of an ordinary force-pump into a small tank, from which it gravitates to three supply-cocks over each bench. The retort-house and engine-room form a substantially-built brick building. The former is about 32 feet by 27 feet, and contains two benches of retorts (with provision for a third), and also a vertical boiler. Each bench is encased around its two sides and top by ½-inch wrought-iron plates, and forms a rectangular block 8 ft. 8 in. high, 6 ft. 7 in. wide, and 7 ft. 8 in. long. The front and back plates are of cast iron, and are easily removed when repair or renewal of retorts is needed.



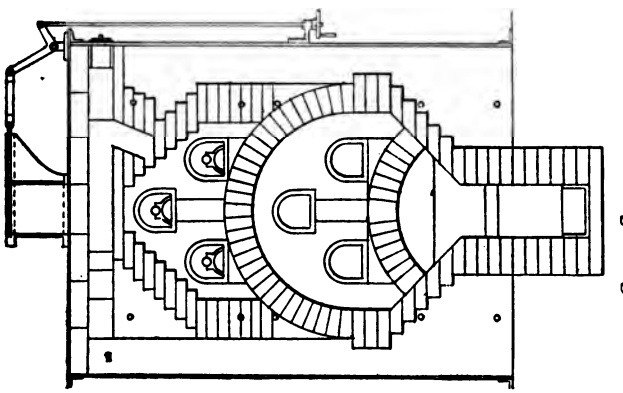
O Oil reservoir.
R Retort-benches.
C Condenser.
P Purifiers; *s* Scrubber.
M Station meter.
H Small holder.
E Compressing engines.
S Store holders.
B Vertical boiler.
T Tar-tank.

FIG. 7.—GENERAL PLAN OF THE OIL-GAS PLANT AT THE INCHICORE WORKS, DUBLIN.

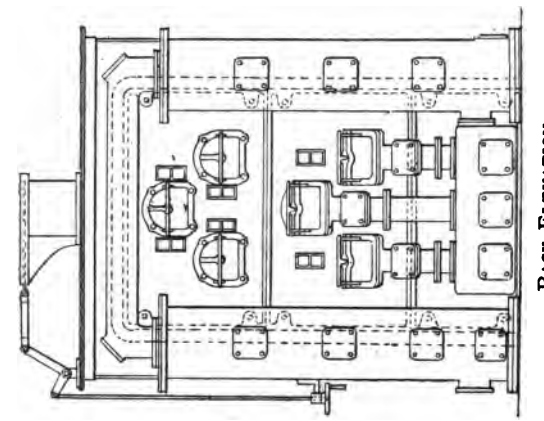
Each bench contains six 8-inch by 8-inch ⊓ cast-iron through retorts, working in three vertical pairs; and these are heated by one furnace. The setting resembles that employed on the London and North-Western Railway, but differs from the general practice in the majority of oil-gas works, where each pair of retorts is heated by an independent furnace. The retorts at Inchicore are 8 ft. 1 in. long over all, and are flanged at both ends. Each of the three upper ones contains a length of 2-inch gas-pipe, running from the front to within 6 inches of the back. The oil in flowing along these tubes is gradually raised to its boiling-point and vaporized; and the vapour returns along the upper retorts to the three lower ones, where it is completely gasified by passing through the latter, which are maintained at a temperature of about 1400° to 1500° Fahr. Each pair of retorts is connected in front by a rectangular pocket. The outlets of both the lower retorts are provided, at the back, with



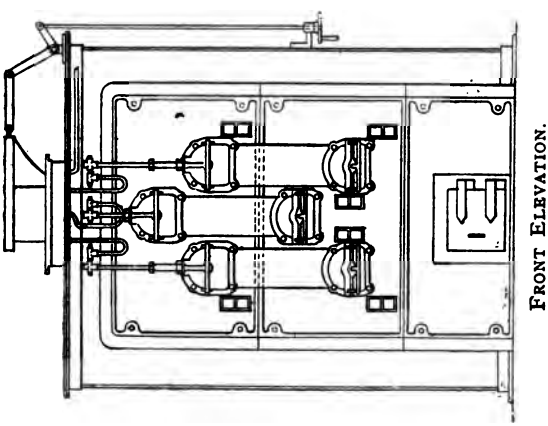
LONGITUDINAL SECTION.



CROSS SECTION.



BACK ELEVATION.



FRONT ELEVATION.

FIGS. 8 TO 12.—DIAGRAMS SHOWING SETTING OF OIL-GAS RETORTS AT THE INCHICORE WORKS, DUBLIN.

three testing-cocks; and these are opened, at intervals, for the purpose of estimating the quality of the gas being produced from time to time.

The issuing gas should be of a pale straw colour, which is an indication that the proper quantity of oil is being admitted. If an excess of oil is allowed to enter, it cools the retorts, and produces a lighter coloured gas, easily condensed. On the other hand, a deficiency in the supply causes the gas to be over-heated; and this is indicated by the issuing gas having a much darker tint, due to some of the carbon separating out in the form of fine soot. A small amount of carbon is removed from the retorts about every alternate day. The mouthpiece lids are luted with painter's putty. The quantity of gas produced from the bench just described is nearly 1100 cubic feet per hour. The economy of fuel effected by the larger bench will be apparent to those accustomed to the working of a furnace to each pair of retorts. No trouble whatever has been experienced by irregular expansion.

The impure gas is conveyed from the retorts, by means of three descension-pipes, to the hydraulic main situated on the floor-level at the back of each bench. A small quantity of water is allowed to constantly trickle through the hydraulic main, which effectually prevents the thickening of the tar—apt to occur at this stage. The gas then slowly passes through two condensers (which contain several perforated iron plates) situated on each side of the hydraulic main. The more viscid tar is here removed; and the plates are cleaned at intervals through suitable doors. The gas then passes through a 6-inch main to an ordinary set of 6-inch pipe condensers; and afterwards through a vertical coke scrubber and two small purifiers, charged with lime and sawdust. It is then conveyed to the meter, located in the engine-room; and, finally, to the gasholder. The latter, by reason of its being a temporary receptacle, has only a capacity equal to about one hour's make. The scrubber has a moveable top with water luting, for the easy introduction of coke, and may be readily bye-passed by a four-way valve. Two similar valves at the purifiers enable them to be worked in any desired order; and their contents remove the small amount of sulphuretted hydrogen and carbonic acid contained in the gas. Many oil-gas works dispense with this part of the purification. Suitably sealed drain-pipes convey the tar away from the hydraulic main, condensers, and scrubber to a large tank embedded in the ground. About 4 gallons of tar are produced per 1000 cubic feet of gas made. During the short time the works have been

in use, the make of gas per gallon of oil has been found to be from 72 to 75 cubic feet, of 40-candle power.

The engine-room next the retort-house is 10 ft. 6 in. by 27 ft., and contains two compressing-engines. The diameter of the steam cylinders is 9 inches, and that of the double-acting compressing-pumps is 6 inches. The cylinders and pumps are arranged tandem fashion, and have a stroke of 14 inches. The steam is obtained from a vertical boiler of about 8-horse power, situated in a corner of the retort-house, and is supplied at a pressure of 70 to 80 lbs. Each engine, when making about 50 revolutions per minute, compresses about 1200 cubic feet of gas per hour. The delivery-pipes are connected to storeage reservoirs, each having an inside diameter of 4 ft. 1 in. and a length of 18 ft. 6 in. They are made from ¼-inch iron plates, welded throughout, and form excellent examples of good workmanship. Each is charged to a maximum pressure of 150 lbs. per square inch, and at this pressure contains 2200 cubic feet of gas. They are provided with suitable inlet and outlet valves, with pressure-gauges, and also draw-off cocks for the removal at intervals, of a very volatile and pungent hydrocarbon, which condenses out of the gas on compression. About 1 gallon of this is produced per 1000 cubic feet of gas compressed; and its deposit causes a slight loss in illuminating value.

Owing to the works being situated some two miles from the terminal station at Kingsbridge, where the carriages have to be charged, it is necessary to convey the gas at full pressure along this distance. The medium used is a Perkins high-pressure wrought-iron pipe, with a bore of ⅞ inch. It is run in 14-feet to 16-feet lengths; and the joints are formed by means of the usual coupling with right and left hand threads, the end of one pipe being coned to a sharp edge where it abuts against the next pipe. [Specimen shown.] The pipe is laid in a creosoted wooden trough, having a section of an equilateral triangle of 6½ inches side; and it was tested by hydraulic pressure, to 200 lbs. per square inch, previous to its being covered with a mixture of boiled tar and pitch. The trough is also utilized for the conveyance of a telephone wire, connecting the gas-works and terminal station; the pipe itself forming an excellent return "earth." Two additional reservoirs are placed about ¼ mile from the terminus; and from these the gas is led to filling-pots, at convenient intervals, alongside the arrival platform.

The carriages are charged in the usual manner from these filling-pots by means of high-pressure flexible hose. Each vehicle is provided with two cylindrical reservoirs, which are

connected—each being 17¼ inches inside diameter and 5 feet long. These reservoirs are made from sheet steel of No. 18 standard wire gauge, with brazed joints and dished ends, and are charged to a maximum pressure of 105 lbs. (or seven atmospheres) per square inch. The time taken in "gassing" a coach is about three minutes. A filling-valve and pressure-gauge are provided at each side of the carriage, to enable the charging to be performed from either side.

With a view of ascertaining the ultimate bursting pressure of these reservoirs, an experiment was recently made by subjecting one, selected haphazard, to hydraulic pressure. Rupture took place at 525 lbs. per square inch, which gives a very fair factor of safety. The rent was longitudinal; and, strange to say, the metal plate gave way, while the joint remained intact.

The gas passes from the reservoirs to the burners through a regulator, which reduces the pressure to 10-10ths on the outlet; and the main supply is carried up to the roof at one end of each vehicle. At a convenient height are fixed a stopcock and a bye-pass. The latter is worked by a horizontal bar from either side, which permits of the instantaneous raising or lowering of the whole of the lights. The supply-pipe runs along the entire roof to the outlets opposite each lamp. The lamps employed are of two patterns—one containing a single burner, consuming 1 cubic foot of gas per hour, for use in second and third class compartments; the other provided with a duplex burner, passing 1½ cubic foot per hour, for first-class compartments. The light from the former averages about 7½ candles; and that, from the latter, about 13 candles. The single burners are adjusted so that the full width of the flame is parallel with the carriage door. This position obviates the shadow thrown by the supply-pipe when the burner is at right angles. A new feature in the duplex lamp is the addition of a lug on the inside lamp ring, through which a vertical spindle actuates a bye-pass cock. A small rotation of this rod by a suitable button carrying an index pointing to the words "on" and "off," places the lowering of the light to a mere glimmer under the control of the passenger. [A sample of each of the lamps described was shown.] These patterns were decided upon, after repeated trials, as giving the best results; for it is hardly necessary to note that the conditions of burning when the carriages are standing are widely different from those produced by rapid travelling in a strong head-wind.

The compressing-engines have been supplied by Messrs. Pope and Sons; the storeage reservoirs and carriage fittings, by

the Pintsch Patent Lighting Company; while the remainder of the gas-works plant has been designed and manufactured at the Inchicore works.

From a lighting point of view, a considerable improvement might be made in the choice of upholstering material for the first-class compartments; the dark-blue cloth commonly used being somewhat suggestive of the walls of a photometer room. If a lighter material were employed, although, perhaps, not so suitable in other respects, it would greatly assist the passengers' reading, by its improved reflecting power. A similar remark is applicable to the dark woods used in many carriage roofs. Veneering with light woods, or painting in pure white or French grey, should be encouraged as much as possible.

In conclusion, it may be added that the carriage reservoirs are of sufficient capacity to last the return journey between Dublin and Queenstown. The branch lines will be supplied from pairs of the large storeage reservoirs, mounted on trucks, which will be run on the main line to the respective junction stations.

Discussion.

The PRESIDENT thought the members would all agree with him that they were greatly indebted to Mr. Outon for his excellent description of the new railway lamp. The paper was an especially valuable one from the fact that Irish railways were very far behind in the important matter of lighting.

Mr. J. WHIMSTER (Armagh) said the subject of the paper was one on which his knowledge was not very extensive. He had read much about it, and had heard papers read; but beyond this, he knew very little. There was, one matter which struck him forcibly. He thought Mr. Outon said that the retorts made 1100 cubic feet of gas per hour, which meant that each retort produced something like 200 cubic feet per hour or 4800 feet in the twenty-four hours. He (Mr. Whimster) would have thought that, under the circumstances, they would have had a greater produce per mouthpiece than this seemed to indicate. With reference to the size of the oil-retorts employed, did he understand Mr. Outon to say that they were 8 inches by 8 inches? and was the object of using such small-sized retorts to bring the heat into closer contact with the oil than would be the case in larger retorts? It was desirable also that they should know if they had any difficulty with the ascension-pipes—did they never get choked with carbon? And, further, he should like to know with what material the furnaces were fired; and if it took a great deal of coke to keep up the heats?

Mr. W. A. VALON (Ramsgate) congratulated Mr. Outon upon his paper; and he expressed his personal obligation to him, as he confessed the author had succeeded in making clear to him several points which had hitherto been obscure in his mind. He, however, had been struck by the same matter as that which had been introduced by Mr. Whimster—that with regard to the production of gas. He also wished to inquire how many cubic feet of gas were made from a ton of oil the specific gravity of which was given at ·840?

Mr. OUTON remarked that the works had been completed only during the latter part of the previous month; and so he had not had a chance of getting many results. The production of gas per gallon of oil used was, he believed, 72·75 cubic feet.

Mr. VALON proceeded to state that most railways were undoubtedly lighted in an indifferent manner. In America, however, it would be quite impossible for the carriages to be lighted after the fashion adopted this side; and it was a great comfort to know that the question was engaging the attention of railway engineers here. He hoped they would succeed in making their railway compartments more endurable for passengers, as far as lighting was concerned, than they had hitherto been.

Mr. OUTON, replying to the various criticisms, said that the largest retorts for oil-gas making—throughout England, at all events—were 10 inches. There was an intermediate size; and another as small as 6 inches. The ascension-pipe (alluded to by Mr. Whimster) never became the least clogged; its function being to gradually raise the oil to its boiling-point, before it returned along the three upper retorts. The heat was much lower than that employed in the production of coal gas. The make of gas was 72·75 cubic feet per gallon of oil used. At present they only worked during the day—not day and night. When the winter season came on, however, and their carriages were all fitted up, it would perhaps be necessary to work day and night. Owing to the very small amount of gas made, he could not give definite information with regard to cost. But he estimated that, when the plant was in full working order over the whole line, the cost of the gas would be about 12s. per 1000 cubic feet—he did not think it would be less. As to residuals, they had no immediate market for the chief ones; but he understood that in England these were readily bought up by chemical manufacturers, who generally paid for their purchase about 1s. per gallon. It had often occurred to him that, where oil-gas works and coal-gas works were combined, all the residuals produced might be usefully employed.

Mr. A. MAIN (Glasgow) next read the following paper:—

THE HISTORY AND DEVELOPMENT OF COOKING BY GAS.

Forty-three years ago, in 1850, there was a somewhat remarkable scene witnessed in the ancient city of Exeter—an incident having for its central figure a very remarkable man, and notable in itself as being somewhat prophetic of a new order of things in one great department of human economy. In the centre of a large crowd, the object of a good deal of jeering ridicule, stood a French *chef*. The Royal Agricultural Society was holding its annual meeting in Exeter; and this French *chef* had been engaged to superintend the cooking of the banquet.

He tells us that he determined to signalize the occasion by serving a new dish—viz., "A Baron and Saddleback of Beef *à la* Magna Charta," weighing 535 lbs., or close upon 5 cwt. To roast such a joint at one time was a difficult thing to do, on account of the immense fire required; and former attempts, it seems, had not always been successful. A crowd gathered, in expectation of seeing a large bonfire lighted; but, to everyone's surprise, all that was visible was an oven 6 ft. 6 in. by 3 ft. 3 in., constructed roughly with a few bricks and a few sheets of iron. Into this temporary oven were introduced 216 very small jets of gas, through pipes ½ inch diameter. The on-lookers were incredulous; saying it was impossible so enormous a joint could be roasted by such means. But, after eight hours' roasting, it was found to be thoroughly cooked, at a cost (in those days of dear gas) of less than 5s.; and it was carried on the shoulders of eight men through the streets of Exeter, preceded by a band playing "The Roast Beef of Old England," and followed by a crowd of some thousands. The hero of this animated scene was none other than the illustrious Alexis Soyer, probably the greatest master of the culinary art ever sent to our shores by France—that country of *la grande cuisine*. Soyer was *chef* to the Reform Club in London, and superintended all the great banquets of his day. He wrote some of the most interesting and fascinating works on cookery which we possess; notably his "Pantropheon"—a book of immense research on the subjects of food and cookery. Soyer tells us, speaking nearly half a century ago, that "he knew well the power and efficacy of gas for cooking."

Such is the first authentic record I can find of the use of gas for cooking purposes. In the following year (1851), at the Great Exhibition in London, a patent gas cooking-oven was exhibited by Alexander Graham, of Glasgow. This oven was

fitted with luminous jets inside—the gas issuing from three small needle holes in each burner; while an iron boiling-ring on the top was provided with similar jets, bored with four holes instead of three. As yet the Bunsen burner had not been used. Mr. Graham was a well-known and highly-respected hotel proprietor and *restaurateur* in Glasgow; and a number of his *confrères* in his city and neighbourhood were induced to follow his example in the use of gas for roasting. Mr. Graham made and sold a limited number of cookers for hotels and restaurants; but as yet the use of gas-ovens for domestic purposes was practically unknown. Mr. Graham was certainly one of the pioneers of gas cookery. About this period we find gas cookers made by Mr. Davis, of Bath; and various makers appeared in London, Birmingham, Leicester, &c.

Very strong prejudices had to be encountered and overcome before gas obtained anything like a popular hold on the ordinary consumer, and thoroughly established itself as an indispensable auxiliary in every first-class kitchen. The average cook, who, with perfect equanimity, exposed a chop or steak to the fumes of a coke or a coal fire, shuddered at the thought of a joint being exposed to the same fuel in a purified state, as received from the gas-works. Only those conversant with the trade in its early stages can recall the extraordinary and unreasonable prejudices which gas had to overcome—prejudices founded, of course, on ignorance, but nevertheless powerful and obstinate.

Now-a-days, when the use of gas as fuel is so universal, we are apt to forget that the trade has only assumed definite and popular form within the last dozen years. It was extremely difficult to sell gas cookers to ordinary consumers; and the trade would never have assumed its present great dimensions but for the fact that gas companies and corporations, alarmed by the first electric light scare, took the matter in hand, and turned their attention seriously to the subject of the value of coal gas as a fuel, and began to hire out the cookers at small rentals. Foremost among these, if not the first, was Mr. Alfred Colson, of Leicester, who entered into the matter with great spirit, and published a very valuable little pamphlet, entitled "The Economy and other Advantages of Cooking by Gas." This pamphlet was circulated in large numbers, and was a powerful means of educating popular opinion on the subject. Mr. Colson began by acknowledging that "the want of knowledge and appreciation of gas as a fuel on the part of the public had been largely due to the apathy displayed by gas companies

generally in bringing before the notice of their consumers the merits of a commodity, of which they were the producers." At the same time, the leading medical journal, the *Lancet*, began to advocate the use of gas for cooking and heating; and this materially helped the extended use of gas for these purposes.

In 1882 a very valuable contribution was made to the subject by Dr. Stevenson Macadam, of Edinburgh, in a lecture delivered to the North British Association of Gas Managers (and published afterwards in pamphlet form) on "The Sanitary Aspects of Cooking and Heating by Coal Gas." By careful and prolonged experiment with the cookers of three leading makers, Dr. Macadam arrived at some very important and definite conclusions. One of these was that the cooking of meat in the gas-oven yielded a larger return of cooked meat than in the coal-oven. It was found (and this has since been amply demonstrated by other experiments), that, while a joint cooked in the coal-oven lost 40 per cent. of its weight in the process of cooking, the same joint would lose only 25 per cent. of its weight in the gas-oven. "To a large extent," says Dr. Macadam, "the difference of 15 per cent. is due to the meat being constantly surrounded by an aqueous vapour derived from the combustion of the gas. The influence of this moist atmosphere not only kept the meat more moist, but hindered the escape and evaporation of the juices; retaining the osmazome or flavouring matter, so that the meat when properly done is more juicy and more palatable, and yet free from those alkaloidal bodies produced during the confined cooking of meat in the coal-oven, which are more or less hurtful and even poisonous." Dr. Macadam further pointed out that the meat, being more juicy, is also more easily digested. This testimony, on the part of so high an authority, had a most favourable and beneficial effect in dispelling the remaining prejudices against gas cookery, and rapid strides were soon made in the direction of improved construction of gas-stoves, and in the number of corporations and companies who hired them to their consumers.

Within the last ten years, the development of gas cookery has been very extraordinary. Exhibitions of gas appliances have been held all over the country, combined with free cookery lectures; and public opinion has been largely educated by this means. One aspect of the question is worthy of notice. We must all be conscious of the immense strides that have been made during the present generation in familarizing the art of cookery in our country. After years of astonishing neglect, our Education Department at last awoke to the fact that cookery

ought to form part of every woman's education; and during recent years County Councils have also expended large sums on this most important department of education. Schools of Cookery have arisen in all the leading centres; and our Board Schools are now equipped with the necessary apparatus for teaching this important branch of domestic economy. It can scarcely have escaped the notice of observant spectators that this vital, but quiet, social revolution could not have attained its present dimensions but for the fortuitous circumstance of a new and much improved method of cooking—the introduction of the gas-oven.

Bound up with this question is the pressing and important matter of the solution of the smoke problem and the purification of the air of our large towns. Our rural population keeps crowding into the city; and as, year by year, the great towns increase in size, the smoke question has become one of the most pressing problems of the day. The question must sooner or later be faced and solved. Various solutions have been offered, but none so satisfactory as that which suggests the use of gaseous fuel, both for cooking and heating. Dealing with this subject a few years ago, the late Sir William Siemens said: "I hold that it is almost barbarous to use raw coal for any purpose, and that the time will come when all our fuel will be separated into its two constituents before reaching our factories or our domestic hearths. Such a measure would not only furnish us with the complete solution of the smoke question, but would be of great value as a money-saving expedient."

The following figures will be of practical value to managers of works where the system of hiring is contemplated. They have been kindly supplied by Mr. W. R. Chester, of Nottingham:—

Some Statistics as to the Purchase, Hire, and Cost of Maintenance of Gas Cooking-Stoves in Nottingham.

The average net cost of 1511 stoves purchased up to the end of the year 1891 was £4 os. 3d. each.

The basis upon which the rental is fixed is as follows: 10 per cent. is deducted from the list price; and the rental is 10 per cent. on the balance. For example, a stove costs £5, or 100s.; 10 per cent. off = 90s.; 10 per cent. on 90s. = 9s. per annum, or 2s. 3d. per quarter. This is about 13½ per cent. on the net cost.

The average period for which a stove remains fixed is five years. The average cost of fixing, which is all done free of cost to the consumer, providing he rents a stove for a whole year, and not more than 30 feet of pipe are required for fixing, is 6s. 6d. per stove. The average cost of removing, cleaning, and repairing a stove is 6s. 6d.

The actual rent received for 1511 stoves on hire is £684, or 9s. each per annum. The average charge on each stove in use is as follows:—

Cost of fixing, one-fifth of 6s. 4d.	1s. 3·0d.
Removing, cleaning, and repairing	1 10·7
Refixing repaired stoves	0 4·4
Inspection and attendance on complaints	1 5·3
Proportion of show-room expenses	1 4·6
Total annual charge per stove in use	6s. 4·0d.

The excess of rental over expenses is thus 2s. 8d. per annum.

In ten years, only five stoves have had to be renewed. The net rental at present received—2s. 8d. per stove per annum—will, at 5 per cent. compound interest, provide a renewal fund to replace all the stoves once in 18½ years. The life of a stove, based on 10 years' experience, will not be less than 18 or 20 years; and therefore the present rental charged will be sufficient to provide against any actual loss on the business, and the profit on the gas consumed is therefore all clear gain.

The average increase in the consumption of gas where 385 stoves have been fixed is 15,438 cubic feet per stove for the first clear year. The gas used for cooking purposes gives an increase to the former consumption of about 4 per cent.

Discussion.

The PRESIDENT said he was sure they were much obliged to Mr. Main for his most interesting and instructive paper. The development of gas cookery was a question in which they were all very much interested; and the more attention that was given to it, the better. There could be no doubt that the sale of gas in the daytime, especially during the summer months, was very valuable. They knew that all their works preferred to have gas made in the daytime. The extra cost required to produce the gas necessary for cookery was, therefore, simply the cost of the coal, less the residual products; and a very considerable margin was thus left. He had often thought that the advantages attending gas cookery were not known, as they ought to be, by gas managers themselves; and this accounted for their apparent apathy in the matter. They ought, as gas managers, to make themselves cognizant of all these advantages; and the only way they could do this was by introducing the stoves into their own dwelling-houses. Then, when they had the information themselves, it was their bounden duty to make it known to the public. Mr. Main had referred to the prejudices existing against gas cooking. In his (the President's) opinion, these prejudices still existed to a very alarming extent. It was a great pity that it should be so; but this very existence

should make them all the more ready to endeavour to inform the public mind on the subject. Mr. Main was evidently unaware of the fact that it was not considered necessary in Ireland that cookery should be an essential branch of the education of girls; but he (the President) hoped the time would soon come when this condition of things would be changed. There was another difficulty connected with the introduction of gas-stoves into houses—that was the servant-girl difficulty, which most of them had experienced. However, they had partially surmounted this obstacle by fitting on lock-taps; and if any of the members intended going in for the hiring-out of gas-stoves, he would strongly urge them to adopt this course.

Mr. E. STEARS (Lisburn) remarked that, as far as his experience went, gas cooking-stoves had given the greatest possible satisfaction. He had been informed that in Manchester no charge was made for the stoves; but he did not consider that they were as far advanced in Ireland as there.

Mr. J. T. CLARK (Edinburgh) inquired if the tap the President referred to was in charge of the domestic or her mistress.

The PRESIDENT replied that it was intended to be in charge of the latter.

Mr. RANSOME (Warrington), alluding to the observations of Mr. Stears, said that, from his own personal experience, the stoves were not let out even in Manchester free of cost.

Mr. WHIMSTER said that his experience with regard to gas-heating stoves was not a very encouraging one. He had them introduced into his own house, though he did not believe in them altogether, for they were too expensive for common use. When people had consulted him with regard to them, he had made a rule of advising them that, if they were prepared to pay for a luxury, they ought to purchase the stove outright. The gas-heating stove was very useful in an office or room, where its use conduced to the cleanliness of the books and papers contained in it. He thought, however, that everyone who could should pay to have a gas-cooker. The domestic servant difficulty was certainly a difficulty which was much experienced in the city he came from; for he thought that, in this respect, Armagh was perhaps more peculiarly situated than some other towns. Many of the ladies there did very little in the kitchen themselves; and the expense which was thus entailed by the negligent use of gas-stoves by servants was really monstrous. In a great many cases, the cost had turned out to be so great that the ladies had refused absolutely

to have anything further to do with the stoves. For himself, he had connected with his gas-stove a meter by which he was able to accurately measure the amount of gas consumed. He strongly advocated the use of gas bath-heaters which were simple and effective; and he thought that householders should be encouraged to use them.

Mr. W. IVISON MACADAM (Edinburgh) said he had no experience as a gas manager, but as a gas consumer he had experience of a cooker which he had introduced into his own house. The stove did its work thoroughly well; but——the "but" was the servant girl (laughter). He thought that if Mr. Main would adopt on his cookers some automatic principle, which would limit the expenditure of gas to the period during which the stove was actually being used—and this should certainly not be difficult—a great step would have been made in advance. As to the use of bath-heaters, he was of opinion that it would not be advisable to introduce many of them; as people now wanted something more than hot-water plunge-baths. Then, with regard to gas-fires, there was no doubt that they were good for offices. In his own library, he found a gas-heater to be a great convenience, and a saving as far as the binding of books was concerned; while it had proved a decided source of comfort to him in his bedroom.

Mr. CLARKE said he had in use an automatic invention of his own by which the consumption of gas in his cooking-stove was regulated.

The PRESIDENT said there was not a single one present but would admit that gas appliances were very efficient; but what they were more anxious about was the development of their gas business. Five years ago, there was not a gas-stove in Coleraine; at the present time there were something like 300 or 400. This result was achieved by simply keeping "pegging away;" and, as a consequence, they had already increased their business by 10 per cent., which was mainly accounted for by the introduction of gas-stoves. They were thus enabled to sell gas in Coleraine cheaper than they had ever done before; and they hoped to have another reduction shortly.

Mr. MAIN, replying to the various speakers, said, with regard to the lock-tap, that it was a very admirable thing, and as a firm they had advocated the use of such an appliance for years, so as to prevent as far as possible the waste of gas. It was very easily fitted; and it was very effective when properly locked. With reference to Mr. Macadam's remarks about an automatic gas supply controller, such a device was in existence; and a very

good thing it was. But the trouble of all automatic arrangements was that they were so easily put out of order. They were then worse than useless; in fact, their last stage was worse than the first. If a thorough automatic arrangement could be devised, there was no doubt that it would be a very good thing. Anent hot-water baths, if they wished a spray bath, it could only be accomplished by having a high-pressure boiler; but he thought it ought to be clearly understood, as one of the most important facts in connection with the development of the gas-stove business, that there was not the slightest difficulty in supplying a very simple and inexpensive arrangement to give water under pressure. A small boiler standing beside a cooker or in any other convenient place, could have a flow and return pipe connected with an ordinary high-pressure tank. This was all that was necessary. With regard to the use of gas-fires, he had always advocated putting them in bed-rooms and drawing-rooms—where proper economy could be exercised; but he had generally advised people against them for other rooms.

The Lecture.

Mr. W. Ivison Macadam, F.R.S.E., of Edinburgh, delivered the following lecture:—

PROCESSES FOR MANUFACTURING GAS FROM OIL, WITH SPECIAL REFERENCE TO THE PEEBLES PROCESS.

That a rich illuminating gas could be obtained by the destructive distillation of oils has been known for many years. In the earlier experiments, the ordinary greasy or fatty oils were employed; but the cost of material was so great that the works erected were rapidly closed. The oils used were principally colza or rape oil and train or whale oil. The amount of gas obtained was from 70 to 90 cubic feet per gallon of oil; while the illuminating power ranged from 30 to 70 candles. The cost was rarely below 25s. to 30s. per 1000 cubic feet. These fatty or greasy oils are combinations of the triatomic alcohol glycerine ($C_3H_5[HO]_3$), with fatty acids, principally palmatic ($C_{16}H_{31}$,HO), stearic ($C_{18}H_{35}$,HO), and oleic ($C_{18}H_{33}$,HO). When destructively distilled, the glycerine passes, to a large extent, into the aldehyde acrolein (C_3H_3O,H); while the fatty acids yield a series of compounds of which the olefines form the greater part. The gas is, therefore, very rich in carbon, and burns with a smoky flame, requiring special burners for its consumption.

Next in time comes "coal oil." This substance is a very complex mixture of carbon and hydrogen compounds. It contains members of the benzol, paraffin, olefine, acetylene, and

other series. It is obtained during the purification of ordinary coal tar, and is sometimes used as an illuminating oil. The specific gravity runs from ·840 to ·850 (water=1·000). It contains proportions of the lower members of the benzol, olefine, and paraffin series, which give it a low flashing-point (65° to 70° Fahr.) and a low burning-point (70° to 80° Fahr.). The yield of gas is however high—averaging over 100 cubic feet per gallon of oil, with an illuminating value equal to about 70 standard candles. The gas is rich in members of the olefine series, of which it contains upwards of 45 per cent. It also contains some members of the paraffin series, but only small quantities of the acetylenes. By the newer processes, this substance should give valuable results.

The most important classes of carbon and hydrogen compounds from which gas may be distilled are the petroleums and paraffins. The first of these terms is more strictly applied to certain naturally-formed hydrocarbons found widely distributed over the surface of the globe. The term "paraffin" has been adopted for the materials derived from shales, &c., when these are destructively distilled in closed retorts with or without the admission of steam, and with or without the presence of air.

The natural hydrocarbons, while widely distributed, not only geographically but geologically, are found in large quantities only in a few localities. In Russia, the Baku deposits have been long known; in Burmah, the substance has been worked for centuries; in Japan and China, in Egypt, &c. With the exception of the Russian deposits, all other localities fall into insignificance beside the enormous underground reservoirs discovered in America. The vastness of these American deposits of natural oil may, perhaps, be better understood when I state that the area already proved, by boring and other means, is over 200,000 square miles, and that the production in the year 1882 reached a total of 30,460,000 barrels, or over 1,279,320,000 gallons, of which Pennsylvania alone sent out 1,174,757,220 gallons. Since then the output has decreased somewhat. In the case of Russia, the export is gradually increasing. In 1882 the total number of gallons manufactured was only 200,000,000; in 1884, the amount had risen to 429,400,000 gallons.

The American petroleums consist, chemically, principally of true paraffins (C_nH_{n2+2}), with an admixture of the olefines (C_nH_{n2}), and traces of the benzols (C_nH_{n2-6}). The Russian naphthas, on the other hand, are, to a large extent, made up of olefines, with some benzenes, paraffins, and acetylenes. They contain little or no solid paraffins. In America especially the

lighter and more volatile members of the paraffin series (methane and ethane) are found in great quantities as natural gas, and are in admixture with hydrogen and small proportions of carbonic anhydride (CO_2). This natural gas is of high heating value, and is of the greatest importance in works requiring heat of great intensity, such as the manufacture of steel.

Paraffin oils are obtained by the destructive distillation of shales in closed retorts. The total volatile matter in these shales varies greatly; but it may be stated at from 16 to 28 per cent., with a probable average of 23 per cent. When heated in the retorts, the yield of crude oil is about 12 to 13 per cent. The specific gravity is from about ·860 to ·880 (water=1·000). The total production of crude oil in Scotland is equal to from 60,000,000 to 62,000,000 gallons per annum. There is also produced during the shale distillation from 4 to 6 per cent. of permanent gas. One sample of this gas gave, on analysis, the following results:—

Carbon anhydride	15·40
Hydrogen	34·
Carbonic oxide	10·72
Methane	4·02
Nitrogen	35·33
	100·00

The gas burns with a pale, almost non-luminous flame; and it is employed for heating the retorts, &c. It gives a hot flame, and is well suited for firing purposes. It is also used for lighting the crude retort-benches; but for this purpose it requires to be carburetted by passage through light naphthas. When the science of oil distilling was less perfectly understood, this gas was purified by means similar to those employed for coal gas, and used for domestic lighting. Now the illuminating agents are almost perfectly separated, and the flame has become practically non-luminous.

Crude paraffin oil is made up to a large extent chemically of members of the olefine series, with less proportions of the paraffins and traces of benzols and some acetylenes. It differs from the natural petroleum, which is more largely composed of true paraffins. The names, in fact, would be more descriptive if the term paraffin were confined to the American natural oil. The American petroleum is not so readily broken up into a permanent gas. In some experiments I made with a sample of burning oil of ·799 sp. gr., I obtained 86 cubic feet of 66½-candle gas per gallon of oil. The decomposition, moreover, was not so complete as with other oils, and consequently when

stored the gas lost a greater proportion of its luminosity by condensation.

Crude shale oil may be distilled into permanent gas with good results. But, as the material is either solid or semi-solid, it is very difficult to work; as even when heated it is liable to "set" in the small pipes leading to the retorts. In some tests made with an oil of ·850 sp. gr., we obtained from a gallon 98½ cubic feet of permanent gas of 50-candle power. The crude oil contains impurities, from which it may be separated by distillation in a current of steam; and the resulting oil gives much better results when made into gas. During the oil distillation, the gravity is reduced to close upon ·800; and a gallon of oil will then yield over 100 cubic feet of 70-candle gas.

Such oils, however, are not well suited for gas making with the older forms of apparatus; as, containing the light volatile hydrocarbons, they are highly inflammable, and are dangerous to store. At the same time they contain the valuable "burning" oils, the solid paraffins, and the heavy lubricating oils. These bodies are generally extracted from the shale oil before the residue is employed for gas making. The process varies in different works, but generally consists first in distillation with steam, then in treatment with sulphuric acid, and afterwards with soda to remove certain nitrogenous alkaloidal bodies belonging to the pyridine series, &c., and tar acids of the carbolic and other series. The oil is then again distilled, but the distillate is "cut" into two portions—(*a*) A light oil, containing naphtha, burning oil, and intermediate oils, with some of the softer solid paraffins; and (*b*) a heavy oil, from which is extracted intermediate and lubricating oils, and solid paraffins of the higher fusing-points. These various fractions are extracted after repeated treatment with sulphuric acid and soda, followed by distillation—this latter aided by a current of steam. The products then are: (1) Light oils or naphthas (·750 sp. gr.), (2) burning oils (·805 to ·830 sp. gr.), (3) intermediate oils (·840 to ·870 sp. gr.), (4) lubricating oils (·870 to ·890 sp. gr.), and (5) solid paraffin.

The light oils or naphthas may be distilled into permanent gas; but they are more usefully employed as solvents for india-rubber, as turpentine substitute for paints, for carburetting (mechanically) water gas, &c. The burning oils give a good yield of illuminating gas. An oil of ·815 sp. gr. gave 100 cubic feet per gallon of gas of 63-candle power; and a second oil of ·830 sp. gr. yielded over 100 cubic feet of 50-candle power gas per gallon of oil. The solid paraffins are too valuable to be economically distilled, even were the mechanical difficulty of

their solid condition overcome. The oil from which the solid paraffins of higher fusing-points have been extracted is "green" oil, and may be readily converted into gas. A sample of ·884 oil gave 102 cubic feet of gas, having an illuminating value of 53 candles. This oil, however, still contains some of the softer solid paraffins, which can be removed by freezing, when the liquid becomes "blue" oil. This class of oil is also used for gas making, with good results. The average result obtained by us may be stated at 128 cubic feet of gas of 54-candle power per gallon of oil. After further purification and distillation, this oil becomes "lubricating" oil of various gravities and "body.' A lubricating oil of ·873 sp. gr. readily gave 102 cubic feet of 61-candle power gas; while a heavy lubricating oil, of ·894 sp. gr., gave 94 cubic feet of 57-candle gas per gallon of oil distilled.

It is, however, with the intermediate oils that the present, as well as the future, of oil-gas making must remain. These oils, after the most careful fractionation and treatment are too heavy to burn in ordinary lamps, as their viscosity is too high to admit of their ascending the wick by their own capillarity. They may, however, be burned to advantage in specially constructed lamps. They are also too light in body for use as lubricants, and are therefore almost waste substances. Before the days of oil gas, these oils were submitted to the process of "cracking;" and in America this is still carried out. The method simply depends upon the fact that the higher members of the olefine series, when subjected to a prolonged application of radiant heat at or near their distillation-point, are converted partly into lower members of the same series, and partly into marsh gas (methane). The paraffins present are almost entirely changed into lower members of the olefine series. By this means the gravity is lowered, and the viscosity destroyed. After a treatment with acid and soda, and a distillation, they may be used for burning in ordinary paraffin-lamps. They, however, never give satisfaction; as, being so largely composed of olefines, they form combinations with the vitriol used in the treatment, and, on being burned, the wicks become loaded with sulphur compounds, and are charred. The products of combustion also contain much sulphurous anhydride (SO_2). Since the demand for "gas oil" has increased, cracking, in this country at least, has entirely disappeared, and the intermediate oils have now a distinct value in themselves. The flashing-point of the intermediate oils runs from 230° to 250° Fahr., and the firing-point is over 280° Fahr. There is, therefore, no danger from volatile inflammable vapours lodging in the store

tanks. The yield of gas per gallon of oil is about 94 cubic feet; and the quality is close on 60 candles. The gas consists of about 35 to 37 per cent. of olefines—with methane, hydrogen, and some benzenes and acetylenes.

Until the last few years, an oil known as "gas oil" was on the market. This product was obtained by distilling the mixed tars formed by the addition of the acid and soda during the various stages of refining the paraffin oils. The gas oil was an amber-coloured liquid, and contained leucolines and pyridines from the soda-tar and hydrocarbons especially rich in carbon. It burned with a very smoky, sooty flame, and gave a gas rich in acetylenes. The manufacturers now find that it is more economical to burn the tars as fuel below the boilers and stills. It is injected by a current of steam, and is a valuable fuel.

The gas made from oil is employed either directly as an illuminant, or else to enrich other gas of a poorer quality. In the processes I propose to describe, I have purposely left out those forms of apparatus which enrich poor illuminating gas by passing it directly through highly volatile hydrocarbons. Such processes are purely mechanical, and result simply in the suspension of the highly volatile liquid in a large body of a permanent gas. The patentees of oil-gas apparatus have invariably attempted to distil the oil by one operation into gas; and their processes require considerable heat on the retorts. As bye-products, they obtain a condensable tar of benzol-naphthalene character, and more or less carbon (*not* coke). The Peebles process, as I propose to show, makes no such claim; and the only bye-product is a hard and valuable coke.

Of the first class, I will describe the processes of (*a*) Pintsch, (*b*) Keith, (*c*) Alexander and Paterson (the Kirkintilloch), and (*d*) Brooks; and latterly I will take up the Peebles process, and show how it differs from the other methods.

Pintsch's apparatus is especially constructed to work burning and lubricating oils, or oils of the class intermediate between burning and lubricating. It is not at all adapted for crude or other oils which set to solid or semi-solid masses at ordinary temperatures. The retorts are Ω-shaped, and are worked in pairs. The higher retort has a moveable tray placed in it, on which is received the oil to be distilled. The intention of the tray is to keep the cold oil from falling on the hot retort surface, and probably damaging it. Besides this, however, it acts as a vaporizer and as a collector of much of the carbon deposited from the oil, and thus aids in cleaning the retort. The oil, having become vaporized and partially broken up or decomposed in this upper

retort, passes by a neck-piece, situated at the back of the higher retort, downwards to the lower retort, where, meeting with a higher temperature, the decomposition into permanent gas is fully accomplished. The gas then passes to the tar-pit, where some dark liquid is deposited, and thence to condensers where it is cooled, and to a washer and purifier, from which it passes to the gasholder. The condensers have nothing very novel about them; but the washer deserves description. It consists of a cylindrical column, in which is suspended an iron tray with a corrugated under surface, so constructed as to spread the gas and compel it to come in contact with the water. The gas passes by perforations in the side of the tray to the upper gas chamber, and thence by a pipe to the purifier. This latter is of the usual pattern, except that the iron tray gives place to a basket-work square, on which is laid the mixture of oxide of iron and sawdust intended to remove any sulphur compounds that may be in the gas.

The quantity of gas produced by this apparatus may run as high as 90 cubic feet per gallon of oil; but, in ordinary working, from 80 to 85 cubic feet is looked upon as a fair return. For each 1000 cubic feet of gas made, about 4 gallons of tar are obtained. This tar has not been very fully investigated; but in some experiments I made, I was successful in isolating several members of the benzene series, some olefines and acetylenes, and a considerable proportion of naphthalene. It is said to find a market on the Continent; but, so far as my own experience goes, it is generally consumed as a fuel below the steam-boiler employed to compress the gas. It yields a good heat, and is well suited for the purpose. At the same time it is a great pity that so much valuable material should be lost. Generally, the Pintsch gas is employed for the lighting of railway carriages, floating buoys, lighthouses, lightships, &c. In such cases, the gas is compressed by powerful pumps into steel cylinders under a pressure of about 13 atmospheres. The cylinders supply the smaller portable cylinders, which, in the case of railway carriages, are generally fixed below the flooring.

On the Thames and Clyde, as well as on several other home rivers, Messrs. Pintsch have supplied floating buoys. These are generally spherical in form, with the lower part removed, and an inverted saucer-shaped bottom riveted on. This form of bottom is found the best to overcome the force of a current. The sphere is surmounted by an iron superstructure, holding the lamp and lens. In the newer form, the gas receiver is an independent receptacle inside the outer sphere. By this

means the risk of damage by collision is, to a great extent, overcome. These gas-buoys are usually charged at a pressure of from 5 to 10 atmospheres; have a consumption of 0·75 cubic foot per hour; give a flame with a candle power equal to about 5 standard candles, but which, by means of lenses, is increased to an apparent 17 to 20 candles; and burn night and day for fully 100 days without re-charging. The buoys are re-charged as nearly as possible each two months; but, having a much larger storeage power, they can be safely left for a longer period. At first, some difficulty was found in keeping the lights burning; but, by means of a very simple form of concussion-box, this difficulty has been completely overcome, and I am informed by the Inspector of the Clyde Navigation Trust that such a thing as a light becoming extinguished is unknown. Besides these buoys, the Clyde Navigation Trust have several light-towers, lighthouses, &c., working with the gas.

As showing the ease of working and saving of cost, I may instance the Garmoyle lightship, which previously required the regular attendance of a man and his wife, with an outlay for wages, oil, &c., of nearly £150 per annum. Now there is no attendant on board; and the gas is charged into two steel cylinders once each two months. The supply of gas is much in excess of the two months' requirements; and on one occasion the gas did not need replenishing till after fully three months, and then it was not exhausted. The cost for gas is about £12 to £16 per annum. The light burns continuously, and requires little or no attention.

All the Clyde installations are fed from one gas-works situated at Port Glasgow; the gas being carried to the various points by a specially-constructed screw steamer, called the *Torch*. This beautiful little vessel carries two steel cylinders, which are kept fully charged; and the boat is always ready to go to any point should an accident occur.

The Pintsch gas is also used for gas-engines, both at Toward Point and Little Cumbrae. The apparatus at Toward Point is of 1-horse power, and works a fog bell; the Little Cumbrae gas-engine is of 6-horse power, and is used to blow the siren. During the compression of the gas, a certain amount of loss is sustained by the condensation of part of the illuminants. This condensation is equal to about a gallon of hydrocarbon per 1000 cubic feet of gas; and the loss of illuminating power is nearly 20 per cent. The initial candle power of the gas is equal to about 50 standard candles for each 5 cubic feet burned. The products under this system may shortly be stated to be, for

12½ gallons of oil, 1000 cubic feet of gas, 4 gallons of tar, and 1 gallon of hydrocarbon. The hydrocarbon consists largely of benzenes.

Many statistics as to the cost of the gas have been published by the various companies using this apparatus. Two of the largest railway companies put the cost, after deducting residuals, but exclusive of distribution or interest on plant, at 6s. per 1000 feet, and their make at from 78 to 80 feet per gallon of oil.

Keith's apparatus differs in the form of retort from that previously described. It consists in a single through retort of Ω shape, but having in the centre, midway between the back and front, a depression. The oil is fed in at the front; and the gas passes out at the back of the retort. This class of apparatus has been adopted by the Northern Lights Commissioners for installations at Ailsa Craig and Langness (Isle of Man). In both cases the gas is used for engines to blow sirens, and in the first case also for illumination. I have had no practical experience with this apparatus; but my father (Dr. Stevenson Macadam), under instructions from the Northern Lights Commissioners, went very fully into the merits of both Keith's and Pintsch's apparatus. The following is a summary of the results he obtained:—

Keith's Apparatus.

	No. 1.	No. 2.
Gas per gallon of oil .	85·05 cubic feet.	84·82 cubic feet.
Illuminating value . .	63·25 candles.	59·52 candles.

Pintsch's Apparatus.

Gas per gallon of oil .	90·70 cubic feet.	103·36 cubic feet.
Illuminating value . .	62·50 candles.	59·15 candles.

I am not aware of the quantity of tar produced in Keith's apparatus, nor how far the gas may be compressed, nor of the loss of illuminating value during compression. Before employing the gas for gas-engines, Mr. Keith dilutes it with one-half its volume of atmospheric air. The apparatus used is novel and efficient. The cost of the gas is stated to be 5s. 9d. per 1000 cubic feet; but this sum does not, I understand, include carriage of oil and coal, wear and tear of retorts, apparatus, &c., nor the cost of labour or distribution.

The Alexander and Paterson apparatus was intended at first for the production of gas from burning oil (·815 sp. gr.). Worked with this class of oil, it readily gave 100 cubic feet of 63-candle gas per gallon. Later, however, I recommended the use of intermediate oils, as gas can be produced from these at a much cheaper rate, owing to the smaller cost of material. In tests made with the apparatus and intermediate oils of ·864 sp. gr.,

94 cubic feet of a 56-candle gas were easily obtained. The apparatus is simple, consisting of a retort, the door of which is perforated to allow of the introduction of tubes. The oil is passed by these tubes to the back of the retort, being largely vaporized *en route*. It then comes in contact with the heated sides of the retort, and is permanently broken up into a gas, which is drawn from the front of the retort. After condensation in upright pipes, the gas is passed direct to the holder. Working with high-class intermediate oils well purified, the want of purifiers to remove sulphur compounds is not felt. The total amount of sulphur in the shale is not usually more than 1½ per cent., and of this only 0·028 per cent. can be traced to the crude oil. During the process of refining, most of this disappears. Where desired, however, the addition of a purifier is readily introduced. The apparatus is simple, easily worked, and especially suited for works or gentlemen's houses. It is working in several places, and is giving satisfaction. Where a pure oil gas of high illuminating power is desired, and where this is not afterwards to be mixed with coal gas, the apparatus is one of the best I know.

The Brooks patent differs from all the foregoing, in so far as it is specially built for crude oils. The retort is most curiously shaped, in a zig-zag fashion; and the special advantage of this form is said to lie in the greater contact of the oil with the heated sides of the retort. The process also differs from the others in so far as there is introduced a current of steam, which is broken up along with the oil; thus increasing the quantity of the gas, although lowering its lighting quality. The process is largely in use in America; and is said to give successful results. It is also patented in this country; but I am not aware of its being worked here. The peculiar form of retort is distinctly against its adoption; and I can see no reason for the form. Experience has clearly demonstrated that the process of gas making from oil consists, chemically, in the degradation of higher carbon and hydrogen compounds to lower forms, accompanied by the production of bodies rich in carbon and free hydrogen, &c. These processes are best carried out by heat radiated from a large surface, and not by direct contact with the metal. Direct contact leads to the production of much free hydrogen, and the deposition of free carbon in the retorts, with consequent loss of illuminating power. This has been fully brought out in experiments made by my father so long ago as 1872, with apparatus packed with coke, and by myself in tests with thin tubes. Further, the temperature

that is required to break up oils into permanent gas of high illuminating value is orange red; while white heat increases greatly the gas produced, but practically destroys the illuminating power. With small tubes, or zig-zag apparatus. it is almost impossible to regulate the temperature.

The Peebles process differs essentially from any of the other processes mentioned; for while these act by one direct heat action, the Peebles process, by means of a lower heat and constant return circulation of the condensable products, only gives a partial breaking up at each circulation. In the newer forms of apparatus, as at Galashiels, the coal-gas and oil-gas retorts are back to back; and the waste heat of the former serves to heat the latter. The retorts need not, however, be so placed, for at Peebles the coal gas and oil gas are made in the same oven; but for economical working the Galashiels setting should be best. The coal-gas retorts are of the usual Ω shape and size, and are set in the ordinary way, while the best form of retort for the oil gas is cylindrical. The Galashiels oil-gas retorts are 9 feet long and 27 inches internal bore; and they are laid with a backward inclination. From the front of the retort, there are ordinary ascension, bridge, and dip pipes to the hydraulic main. The condensers are nearly horizontal, with a slight upward tendency, and lead to a scrubber, on the same principle as that adopted in shale-oil works. The trays in the scrubber are fed with oil from a cistern attached to the upper part of the apparatus. From the scrubber, the gas passes to the ordinary dry purifiers, where it meets with the coal gas; and the mixed gases then go to the holder in the usual manner. The oil-feed to the retort is obtained from what is called the compensating-tank. In this tank the overflow from the hydraulic main, the liquids from the condensers, and the fresh oil are intermingled, with the result that a perfectly liquid substance is maintained throughout the whole of the working. Moreover, the apparatus, being of considerable size, acts as a settling-tank, in which any solid carbonaceous matter is removed. The oil passes from the compensating-tank by means of a pipe, with a regulating-valve, to the ascension-pipe, where the introduction of the liquid oil tends to wash the ascending gas, and remove any suspended carbonaceous particles. By this circulation method, all liquid residuals are avoided; and the residue left in the retort, when it is coked down, is a dense and very pure carbon, with less than 0·5 per cent. of ash, and readily burned. For this solid residue, 20s. per ton has been regularly obtained at Peebles. It yields a smokeless flame of great heat-intensity. The gas yield by

this method runs, with "blue" oils, from about 85 to 86 cubic feet per gallon; and the illuminating value when the gas is burned *by itself* is about 59 candles. When burned in admixture with poorer illuminating gas, the value is much greater. A month's actual working yielded—

Coal gas . . .	1,217,600	cubic feet of	18·00-candle power.
Oil gas . . .	253,400	,,	,,
Total gases . .	1,471,000	,,	,, 30·51 ,,

Coal gas . . . . 1,217,600 ÷ 5 = 243,530 × 18·00 = 4,383,360 candles.
Total gas . . . . 1,471,000 ÷ 5 = 294,200 × 30·51 = 8,976,042 ,,

Therefore the candle power from 253,400 cubic feet of oil gas= 4,592,682 candles, which, divided by the make (253,400 cubic feet) = 18·12 candles per cubic foot, and multiplied by 5 = 90·60-candle power as the true illuminating value of the oil gas *as an enricher*. This gain in illuminating value by mixing is equal to 53·74 per cent. To explain this gain, we need to consider several points. When any complex body is subjected to a sufficient amount of heat, it is resolved into its elementary constituents, or into more simple bodies. If the heat applied be great enough, the ultimate particles will be driven so far apart that chemical union is rendered impossible. If, on the other hand, the heat is less, only partial decomposition results; and the substances produced are still compounds, although less complex than the original substances acted upon. If the oil be subjected to the highly-heated surface of a retort, the decomposition is almost complete—methane is formed, any oxygen goes into carbon monoxide or dioxide, hydrogen is set free, and all excess carbon is deposited as free carbon. If, on the other hand, the heat from the furnace is compelled to pass through the sides of the retort, and to be communicated to the atmosphere of the retort, which, in its turn, radiates the heat on the volatilized oil, the resulting decomposition will not be so complete, and the gases left will be more complex in nature, and more highly carbonaceous. To produce light from carbonaceous gases, the carbon requires to be set free, and then raised to a considerable temperature, so as to become incandescent. The incandescence may lead only to a glow, or, as the temperature rises, to a more decided light. If in the gas-flame the heat (in this case derived from the burning of the hydrogen, carbonic monoxide, &c.) is sufficient to produce a sufficient temperature, the maximum of light will result. If the heat is not great enough, then the flame becomes smoky, and the light less. In oil gas the last condition holds good; and the balance is brought about by the admixture with a poorly

carbonaceous gas containing much hydrogen, and which on burning gives sufficient heat to render the excess carbon of the oil gas incandescent. In other words, the excess of carbon in the oil gas is rendered incandescent by the excess of the heat-producing bodies in the poorer gas; and the result is an excess of light over that obtained from either gas alone. The 18-candle splint gas becomes valuable as an enricher on account of the excessive heat of its combustion; and the 59-candle power oil gas enriches on account of its excessive carbon. Both gases are required to give the desired result, and both therefore have a claim on the excess of light obtained from admixture.

I have seen the Peebles process on several occasions, and can testify to the ease of working and regularity of product; and I feel sure that the process has a great future.

VOTES OF THANKS.

Mr. WHIMSTER said he thought the members would agree with him that they were all deeply indebted to Mr. Macadam for coming to Coleraine to deliver his lecture, to which they had listened with a great deal of pleasure. He therefore begged to move that the best thanks of the meeting be given to Mr. Macadam for his valuable services, and also that he be elected an honorary member of the Association.

Mr. OUTON seconded the motion; and it was passed by acclamation.

Mr. MACADAM acknowledged the compliment, and, in doing so, assured the members of his readiness to render the Association every assistance he could in the way of information or otherwise.

A vote of thanks was also accorded to the President and other officers, for their past services.

The PRESIDENT having replied, the proceedings terminated.

PRESENTATION TO MR. WHIMSTER.

The members afterwards dined together in the Cloth Workers' Arms Hotel. The proceedings were specially interesting from the fact that the occasion was chosen to recognize, in a tangible manner, the great services rendered to the Association by Mr. Whimster. This was done by the presentation of a handsome gold watch, on which the following inscription was to be engraved: "Presented to Jas. Whimster, Armagh, by the North of Ireland Association of Gas Managers, as a token of their appreciation of his services in the formation of the Association in 1887, and his services as Honorary Secretary since. August 8th, 1893." The presentation having been made by the President, Mr. Whimster suitably acknowledged the gift;

saying he should prize it not only on account of its intrinsic value, but because he knew it was the expression of real good will and brotherly feeling. He was proud to be looked upon as being in some measure responsible for the formation of the Association, though he often thought the part he then took was no more than just laying hold of the opportunity to organize and direct a spontaneous movement at the time when it was ripe for evolution. He then referred to the first meeting in Armagh; to the subsequent gatherings in Lisburn, Newry, Dundalk, Belfast, Dublin, and Coleraine; and to the social intercourse and good fellowship they had engendered. He said he thought that, as individuals, they had all profited by the Association, and were, through its influence, better men in relation to their work.

On the following day, the members and visitors, accompanied by lady friends, had an excursion to the Giant's Causeway.

MANCHESTER INSTITUTION.

QUARTERLY MEETING, SEPT. 1 & 2.

This Meetiug was held at Nottingham, under the presidency of Mr. W. R. CHESTER, the Corporation Gas Engineer; and, for the first time in the history of the Institution, the proceedings extended over part of two days.

Most of the members from the Manchester district reached Nottingham about six o'clock in the evening of Friday Sept. 1. Later on, accompanied by the President, they visited the Castle Museum and Art Gallery, and the curious dungeons and subterranean passages in connection with that historical site. Then they went to the Natural History Museum, at University College to inspect, in particular, the installation of lighting and ventilating by gas designed and applied by Mr. Chester. The members were met at the museum by Mr. J. W. Carr, M.A., the Curator and Natural History Professor, and spent a very pleasant time at the place. The lamps with which the museum was lighted were of the Wenham type; and for the purposes of ventilation, horizontal tubes were laid above the ceiling from one building to the other. Into these, the products of combustion passed, together with a large quantity of vitiated air from the rooms; and these were afterwards carried into vertical shafts run through the roof, and were thus dissipated into the atmosphere. This system of lighting and ventilating had been also applied to the Free Library of University College, where formerly difficulty was experienced in regard to ventilation. The result in both cases was highly satisfactory.

The programme for the following day commenced with a visit to the subways under King Street and Queen Street, designed and carried out by Mr. Arthur Brown, M.Inst.C.E., the Borough Engineer. These subways had been prepared for the reception of the sewers, gas and water pipes, telegraph and telephone wires, and the cables for electric lighting. They ran under the footways, with suitable branch connections to the houses on either side. They were roomy, well-ventilated, and approached by manholes at suitable distances.

The rest of the day was occupied in visits to the gas-works at

Eastcroft and Basford and the chemical works at Giltbrook. About an hour and a half was devoted to an examination of the alterations and extensions of the works at Eastcroft, which were in a very interesting state. Plans were exhibited in the store-room over the new engine-house; and from these, and the works in progress, the members derived much information.

Waggonettes afterwards conveyed the party to the extensive works at Basford. In connection with the new sulphate plant at these works, a series of settling-tanks had been arranged for the reception and treatment of the waste liquor from the sulphate of ammonia stills. In these the solid refuse was deposited, and the purified liquor was then discharged into the sewers. Thus the cost of evaporating the liquid into steam was saved. The retort-house, in which the new regenerative furnaces were being erected, was of exceptional length, and had a capacity equal to forty-eight beds. As to the coke breaking and washing arrangement (referred to in the particulars furnished by Mr. Chester, given later on), the water was pumped from a well on the works, and after being used was allowed to run to waste. In the washing-boxes the necessary agitation of the water and material was produced by means of an air-blast. The fine refuse was utilized on the works for steam-raising purposes. In reference to the experimental plant, this was capable of dealing with the gas from one of the beds of retorts, and was a complete gas-works in miniature. Its use for coal-testing purposes was, in an ordinary way, extended over three days; the quantity of coal tested being about 20 tons. Great interest was also taken in the apparatus in the meter-house for registering the contents of the different holders. This was contrived by means of a reservoir of glycerine on the top of each holder, communicating by means of a tube with the Bourdon gauges in the meter-house. The gauges were regulated to the height and capacity of the different holders with which they were connected; and the quantity of gas in store could thus be seen at a glance. When passing the purifier-house, Mr. Chester directed the attention of the party to the evidence remaining (in cracks and slight displacements of the building) of the serious effects of the explosion which occurred in the tar-well, as described in the paper read by him before the Institution at the meeting in November last.* Mr. Chester stated that, since the explosion, he had endeavoured to guard against a similar inexplicable occurrence by carrying the sealed ventilation pipes right to the bottom of the tanks; and

* See "Reports of Gas Associations" for 1892, p. 402.

he had also provided vents for the gases held in solution in the tar, in order that it might be separated previous to entering the tanks. He had also closed the tanks with sealed manholes.

On the conclusion of the tour of the works, the party were entertained by the Corporation to luncheon in a marquee erected on a portion of the land provided for future extensions. Mr. Alderman Ford, the Vice-Chairman of the Gas Committee, presided (in the absence through indisposition of Mr. Alderman Barber, the Chairman of the Committee). Mr. Joseph Bright, the Sheriff of Nottingham, and Sir Samuel G. Johnson, the Town Clerk, were also of the company.

A few minutes sufficed for the disposal of the formal business. The minutes of the last meeting were taken as read; and afterwards Mr. E. Jones, Manager of the New Mills Gas-Works, and Mr. James Bailey, Manager of the Middlewich Gas-Works, were elected members of the Institution. On the motion of the President, seconded by Mr. J. Braddock, of Radcliffe, a vote of thanks was passed to the Corporation for their hospitality.

A drive of about eight miles took the party to the Giltbrook Chemical Works; and the members spent some time in viewing the arrangements at these works. They afterwards drove back to Nottingham, where they had tea together at the George Hotel, and then left for home.

The weather throughout was beautifully fine; and the programme—arranged by the President, the Senior Vice-President (Mr. Braddock) and Mr. S. S. Mellor, the Hon. Secretary—was carried out most satisfactorily.

In connection with the meeting, Mr. Chester had prepared the following interesting particulars as to the gas supply of Nottingham:—

The gas supply to the town of Nottingham (at that time boasting a population of about 40,000 inhabitants) was inaugurated in 1818, in which year a number of its enterprising citizens banded themselves into a Company, and obtained from Parliament an Act entitled, "An Act for Lighting with Gas the Town and County of the Town of Nottingham." The Company commenced under the title of "The Nottingham Gas Light and Coke Company;" and they were empowered to manufacture "inflammable air, coke, oil, tar, pitch, asphaltum, ammoniacal liquor, and essential oil, from coal, and to lay pipes for the purpose of the better lighting of the streets, squares, and market-places, and for the lighting of private houses, public buildings, and market-places within the said

town and county of the town of Nottingham." For this purpose, the Company were authorized to raise capital stock to the amount of £16,000 in £50 shares, and to raise a further sum of £5000 on loan—the price charged for gas being 12s. per 1000 cubic feet. The profits on the original stock were to be limited to 10 per cent. per annum.

The Company were incorporated in 1842; and further powers were then obtained to raise their capital stock to £40,000, and the loan capital to £13,000. The dividends payable on the new stock were not to exceed 10 per cent. per annum. But should the profits exceed this, they were to be set aside for contingencies, to the amount of £4000; and then future excesses were to be absorbed in the reduction of the price of gas.

In 1849, the Company were in Parliament again, for a further extension of powers—to increase their capital stock to £85,000, and the loan capital to £25,000, on the same terms as before as to dividends. But this time the auction clauses were introduced; and Parliament stipulated that all new stock issued should be sold by public auction; and the premium realized from its sale was to form part of the new capital, but to bear no dividend.

In 1853, the previous Acts were repealed, and a new Act was obtained, entitling the Company to raise their capital stock to £200,000, and the loan to £40,000. The whole of the capital for the future was to be limited to a 5 per cent. dividend; and the new shares were to be sold by auction. The premium realized was to be used for capital purposes, but not to be entitled to dividend.

The Company were again in Parliament in 1858; and they then obtained powers to raise their capital to £400,000. The new shares were to bear the same rate of dividend, and to be sold by auction as issued—the premium realized to bear no profit as before. The principle of the sliding-scale was introduced for the first time; the Company being empowered to receive an increased dividend of 10s. per cent. when the price of gas was lower than the standard scheduled. This varied from 3s. 1½d. to 3s. 6½d. per 1000 cubic feet according to consumption, ranging from 25,000 to 200,000 cubic feet per quarter. The illuminating power of the gas was also fixed; and for the future it had to be equal to 12 sperm candles.

In 1864, power was obtained to extend the district of supply; and the average meter system was introduced. Restrictions were placed on the Company to supply all public lamps by meter—one meter to be fixed to every twelfth lamp, and every

lamp to be supplied through a regulator, the cost of which was to be charged to the public authority. The registration of the meter was to be taken as representing the average consumption of the twelve lamps. The price charged for the gas consumed in the public lamps was to be at the same rate per 1000 cubic feet as the lowest price charged to any private consumer.

In 1873, the Company obtained power to double their capital; but in 1874 the undertaking was sold and transferred to the Corporation. The terms of purchase were that for every share of £50 the Corporation should pay an annuity amounting to £3 2s. 6d. during the first seven years from the date of transfer, and afterwards a perpetual annuity at the rate of £3 5s. for every share of £50 held by the proprietors. The annuities were to be secured on the revenue of the undertaking, and afterwards on the borough fund and rates leviable in the borough of Nottingham. The mortgage or bond debt of the Company was continued a first charge on the undertaking in the hands of the Corporation.

The district at the time of the transfer was a most extensive one. The Company had run their mains out in all directions, to supply the numerous and populous villages in the vicinity; and one of the conditions for the withdrawal of opposition by the outlying districts to the passing of the Bill, was that the Corporation should abolish the differential charges which had been hitherto made by the Company, and for the future should supply all the parishes then taking gas at the same price as that charged to the consumers in the borough. The area of the district of gas supply is, I believe, the largest throughout the country—extending over 133⅓ square miles; or, roughly, it is 12 miles long by 12 miles broad, and the consumer at the extremity obtains his gas at the same price as the one whose house immediately adjoins the gas-works.

Up to the time of the transfer, the consumption had been regularly doubling itself every ten years; and the necessity for a large extension of the works had become imminent. The Corporation rapidly acquired additional land, and proceeded with considerable extensions at Basford and Radford. The rate of increase continued at the same ratio during the next ten years; but it has considerably fallen off during the last decade. In 1854, the consumption was 118 millions; in 1864 it was 289 millions; in 1874, 572 millions; in 1884, 1162 millions; and in 1894, it is estimated it will be 1450 millions.

During the ten years which followed the transfer to the Corporation, the business was so successful that a reduction in

price of 1s. per 1000 cubic feet had been made in six equal instalments—thus bringing the price of gas down to 2s. 2d., 2s. 3d., and 2s. 4d. per 1000 cubic feet according to consumption. Since then the increase in the cost of coal has necessitated a temporary rise of 2d. per 1000 feet in the price of gas, leaving the scale of charges to-day at 2s. 4d., 2s. 5d., and 2s. 6d.

In addition to the very considerable reductions which were made in the price charged to the consumers, the Corporation have been able to build up a reserve fund of £100,000, and hand over for the improvement of the town, during the last twenty years, more than £250,000. The present capital stands at £914,419, or £6 7s. 7d. per ton of coal carbonized. The coal carbonized during the past year was 143,355 tons.

The gas is made at three works—Eastcroft, Radford, and Basford—all of which are in communication with each other by means of trunk mains. The maximum daily output of gas is about 8½ million cubic feet.

In addition to gas, the Corporation work up both products, tar and ammoniacal liquor, manufacture sulphuric acid, consume their own spent oxide of iron, and make all the new oxide for their requirements. The chemical works are situated about eight miles from the town; and the products are conveyed there by rail or canal. A sulphate plant has, however, been erected at the Basford Gas-Works, to deal with the liquor produced at these and the Radford works. The result has been a saving of from £2000 to £3000 a year.

In addition to the gas and chemical works, the Corporation possess, in the heart of the town, a handsome block of buildings, consisting of a show-room for gas-stoves, and workshops in connection with the distribution department.

The public lighting of the borough is in the hands of a separate Lighting Committee, of which the Vice-Chairman of the Gas Committee is the Chairman. There are about 3500 lamps in the borough, of which a large number are of modern type and high candle power.

The main features of interest to be inspected at the Eastcroft works are the new block of buildings in process of completion, constituting the purifier-house, the tar and liquor storage tanks, engines, meter and governor house, boiler-house, store-room, and overhead tanks for water, tar, and ammoniacal liquor. The purifiers, a set of four, each 40 feet by 30 feet, are elevated about 10 feet above the floor, and rest on columns and girders. Beneath them is a floor for revivifying purposes, on which two lines of rails are laid, to enable the purifiers to be

discharged direct into railway waggons when desired. The purifying material will be elevated by an endless chain and buckets. The purifier covers, which each weigh about 14 tons, will be raised and lowered by hydraulic "Goliaths."

Beneath the revivifying floor are the tar and liquor storeage tanks, about 15 feet deep, and extending over the whole area of the purifying house. These tanks are constructed of brickwork laid in cement, with a waterproof lining of a pitch preparation filled into a cavity left in the walls for the purpose. The capacity, when full, is equal to about 28 days' maximum make of tar and liquor. In the engine-house there are two station-meters of 100,000 cubic feet per hour capacity each; two gas-exhausters and engines of similar power; also one of 60,000 cubic feet per hour capacity. There are four of Cowan's patent governors—two 24-inch, one 18-inch, and one 14-inch. There is also a set of 6-inch water-pumps and an engine and dynamo for the supply of electricity to the whole block of buildings, which will be lighted by from sixty to seventy 16-candle power incandescent lamps. This system of lighting has been decided on, on account of the greater degree of safety which attaches to the incandescent lamp than is possible to attain with any system of open-flame lighting.

The various engines are to be supplied with steam from three Lancashire boilers, each 28 feet by 7 feet, fitted with a fan-blast and Perret's patent dust-fuel furnaces. A new chimney stack, 105 feet high, has been erected for these boilers. Above the boilers is a set of cast-iron tanks for water distribution over the works, and for the loading of tar and liquor into boats or railway trucks. These extensions have been designed for a daily make of gas ranging from 3 to 3½ million cubic feet per day.

Two of the gasholders are in process of being converted from two-lift holders into four-lift ones, thus increasing the capacity by about 87 per cent. One holder has already been converted, and is at work; and a fourth is about to be commenced and treated in a similar manner. The upper lift of these holders goes right out beyond the framing, and is guided entirely by the Pease system of steel-wire ropes.

The whole of the above new work, which is in large part a renewal of plant worn out and outgrown by the productive capacity of the rest of the works, is being carried out at a cost of about £40,000; and, when completed, all the apparatus will be well up to its work, and in proportion to the maximum output of gas.

Another feature of interest at these works is the system of

gaseous firing in the retort-houses. The retorts in each house have been converted to the regenerative system during the past three years. Great economy resulted in labour, fuel, and wear and tear—besides which the output of gas has been increased more than 50 per cent. on the same area of ground. The retorts are all fitted with the most modern appliances. The waste heat is utilized to the utmost in raising the temperature of the cold air on its way to the combustion chamber; and finally, before entering the chimney, it is made to do duty in raising steam for use in the furnaces below ground.

At the Basford works, the most interesting features are: The new sulphate of ammonia plant erected two years ago to deal with 90 tons of liquor per day, and the Claus sulphur-recovery plant in connection therewith. The cost of the plant, buildings, fittings, and all complete was about £6000, the whole of which will be recouped from diminished working expenses in rather less than three years.

In the large new retort-house, there are ten beds of regenerator settings of retorts in process of erection; each bed containing eight 20-feet through retorts, to be fitted up with all the best modern appliances, including a water-tube steam-boiler for feeding the furnaces.

Adjoining this house is a newly-erected coke-breaker and washing-machine, capable of dealing with 30 to 40 tons of coke per day. The coke is broken and sorted by means of a revolving screen into four sizes—three of which are washed and cleansed for smithy use. There is a good market for coke thus prepared, in which the demand is steady and fairly constant throughout the year. Two scrubbers are in process of being lengthened.

Another feature of interest at these works is the experimental plant for coal-testing, and the laboratory for testing the various other products.

The works stand on an area of about 22 acres, and have retort power for producing about 5 million feet of gas per day. The retort-house capacity is largely in excess of this figure.

At the Giltbrook Chemical Works, there are many features of novelty and interest to gas engineers. The sulphuric acid plant is capable of producing 40 to 50 tons of vitriol per week; being provided with burners for coal pyrites or spent oxide of iron. The acid is partly made from each of these materials; and it is turned out at a specific gravity of 120° Twaddell.

The sulphate of ammonia plant belongs to an old type, and is capable of producing from 30 to 40 tons of sulphate per week.

The greatest drawback in connection with this plant is the difficulty of disposing of the waste liquor, the whole of which has to be evaporated, and dissipated in the atmosphere in the form of steam. This, together with the cost of carriage of the crude liquor, raises the working expenses for sulphate manufacture here much beyond the figures attainable at Basford.

The tar-works are a source of interest in themselves. They are capable of dealing with 300 tons of tar per week. The tar is split up into crude products only, for all of which there is a separate and distinct market. At these works, new oxide of iron is made to meet the requirements of the various works; the production being equal to about 600 tons per annum.

SOUTH-WEST OF ENGLAND ASSOCIATION.

HALF-YEARLY MEETING, SEPT. 12.

This Meeting was held at the Imperial Hotel, Exmouth—Mr. E. C. RILEY, of the Great Western Railway Gas-Works, Swindon (the President), in the chair.

MINUTES OF LAST MEETING.

The minutes of the previous meeting (*ante*, p. 59), were first taken as read, excepting the one recording the two resolutions regarding the question of the federation of District Gas Managers' Associations. This was read by the HON. SECRETARY (Mr. Norton H. Humphrys, of Salisbury).

On the motion of the PRESIDENT, seconded by Mr. SAINSBURY (Trowbridge), the minutes were adopted—the former stating, with respect to the subject of federation, that it had been arranged to hold a conference of representatives of District Gas Associations on the following Saturday week, at the Westminster Palace Hotel.*

A WELCOME TO DEVON.

Mr. H. F. WILLEY (Exeter) said, as a resident of Exeter, and as one who had been connected with the gas industry for nearly half a century, he had, on behalf of the gas engineers of the district, to express the great pleasure they all felt at the Association again honouring the West of England with their presence.

Mr. W. A. PADFIELD (Exeter) supported the remarks made by Mr. Willey.

The PRESIDENT, on behalf of the Association, briefly thanked both gentlemen for their kindly observations.

ANNUAL ACCOUNTS.

The HON. SECRETARY then submitted the accounts for the twelve months ended Aug. 31. They showed that the receipts

* Mr. Humphrys subsequently announced that he had "found it impracticable to arrange for this meeting."

(including £1 2s. 10d. brought forward) amounted to £33 3s. 4d.; and the expenditure, to £24 17s. 3d.

On the motion of the PRESIDENT, seconded by Mr. CORNISH (Bridgwater), the accounts were adopted.

ELECTION OF OFFICE-BEARERS.

The SCRUTINEERS (Messrs. Nicholls and Osmond) reported that the following gentlemen had been elected to hold office during the ensuing year:—

President—Mr. N. H. Humphrys, of Salisbury.
Vice-President—Mr. F. G. Dexter, of Winchester.
Hon. Secretary—Mr. H. Sainsbury, of Trowbridge.
Auditor—Mr. W. Higgs, of Basingstoke.
Members of Committee—Mr. F. F. Farrand, of Ryde; and Mr. H. C. Shepherd, of Swindon.

Mr. HUMPHRYS thanked the members for the honour done him in electing him President for the ensuing year.

Mr. DEXTER also thanked the members for electing him to the important post of Vice-President.

Mr. SAINSBURY observed that the Committee had requested him to take the secretaryship for twelve months, while Mr. Humphrys held the office of President.

THE SPRING MEETING.

Suggestions having been invited as to the town at which to hold the spring meeting,

Mr. HUMPHRYS said, in accordance with precedent, it would give him very much pleasure if the members would do him the honour of holding the meeting in Salisbury; and he would do all he could to make the visit an enjoyable one. It was nearly ten years since they met in Salisbury; and he was desired by Mr. Hardick to say that he quite looked forward to once again receiving the Association there.

Mr. WILLEY (who had previously made the proposition, and now withdrew it, that the meeting should be held at Torquay) seconded the motion, which was unanimously carried.

PRESIDENTIAL REMARKS.

The PRESIDENT then addressed the members as follows:—

Since I had the pleasure of welcoming the Association to Wormwood Scrubs in April last, two of the most important matters of general public interest that have had a special and direct relation to the gas industry have been the remarkable long-continued dry and hot weather of this most exceptional summer, and the unfortunate coal strike that has done so much

to dislocate the trade of the whole country—the former resulting in a much smaller consumption of gas, and the latter causing a certain amount of difficulty and anxiety in obtaining the raw material gas managers have to work with. In referring to the latter, I think it is not only permissible, but extremely desirable, that Associations like our own should express a very decided opinion that it is important that some method of dealing with great conflicting questions between capital and labour should be established which would afford a basis for equitable investigation and decision, which would prevent an industrial war injurious and, to a certain extent, dangerous to the community at large. I am aware that the question of official and authoritative arbitration in industrial questions is surrounded by many difficulties; but, if the obstacles can be overcome in important international disputes, I can scarcely believe that the resources of statesmanship of the nineteenth and twentieth centuries would fail even here.

I have been strongly impressed for some time, from the variety of lighting arrangements to be found over the extensive system of a great Railway Company, that gas managers should regard themselves as competitors for the provision of light, heat, and motive power with rivals who have special spheres of usefulness under certain circumstances that commend them to users in many important points, and not in any sense as monopolists. And, if the adoption of gas extends proportionally to what we believe its advantages and value entitle it, managers must be prepared to make some effort and take some trouble to show how gas can be most advantageously and attractively applied. The two great rivals we all recognize are petroleum and the electric light; and I think I have correctly placed them in the order of the extent of their adoption. I will illustrate this by some instances that have come under my own notice. The first was a case of outdoor lighting over a large area; and estimates were obtained for lighting with petroleum and gas respectively. In regard to the former, lamps which were rated at 200-candle power were specified, and their value calculated on a certain consumption of oil per hour; and, on this basis, the cost of a given quantity of light was able to be arrived at. A separate estimate of the prime cost of the installation was also supplied. In the case of gas, the same method was observed. A given number of lamps of 150-candle power were specified at a certain consumption of gas per hour; and, in the comparison, the 200-candle power petroleum lamps came out the cheapest—*i.e.*, comparing the cost per candle as they had

been rated—and were consequently adopted. After the new lighting had been in use a short time, some disappointment in the result was evidently felt, and comparisons to the disadvantage of the oil-lamps were made with nominally 150 and 100 candle power gas-lamps at other places; and eventually one of the petroleum lamps was sent to be properly tested by a photometer, with the result that an average maximum of only about 45-candle power was obtained with the best procurable oil. The makers were unable to credit this result, and were invited to send their representatives to be present at some further tests, and provide their own oil and lamp-trimmer. This was done, but with the same result, except that on one occasion, with the wick specially saturated by hand, and trimmed abnormally high, a light of 79 to 80 candle power was obtained for about five to seven minutes; but frequently the average light was only 25 candles. I think, without any further comment, that the misleading character of the comparison referred to will be seen, and that the nominally cheaper light was only giving about 20 per cent. of the light specified in the estimate which obtained petroleum the installation. A further inquiry as to the grounds on which a result of 200-candle power was claimed in the estimate elicited the reply that the burners were purchased in Birmingham, and the makers or vendors called them 200-candle power burners. The other illustration I will give has reference to the electric light. A large company, having a private works for their own gas supply, obtained a very fine installation of the electric light, with the result that the quantity of gas required from their own works was reduced by from one-third to one-half; but, since the completion of the installation, from various causes—such as the extended use of gas for special industrial processes, and for the avoidance of the cost of the provision of day current when the work on the dynamos would be so unprofitably light—the consumption of gas has quietly and steadily grown, so as to have nearly attained the same figure as before the electric light was provided.

It appears to me that the moral of these illustrations is that gas managers should take every opportunity of showing the real value and usefulness of gas, and special efforts should be made to adapt its use to special purposes such as automatic water and other kinds of heaters, as well as the provision of lamp fittings or apparatus specially designed to meet some peculiar or unusual requirements; and thereby establish the conviction that, in some form or other, gas is essential to civilization in its higher development both of industrial efficiency or personal or

domestic comfort. One other instance I will just mention is the case of an underground establishment, which was somewhat difficult to light effectively, and which required artificial light to some extent during the whole 24 hours. An improved lamp or burner was inquired for; and, to meet the case, and endeavour to obtain the best result at the least cost, three different types of lamps were shown, and fixed temporarily for inspection and approval, and a portion of the establishment was afterwards fitted with the one most approved of the three, for a more extended trial and test. These are the lines I would venture to submit should be followed, if gas is to maintain and improve its position in face of the rivals which are so earnestly competing for a share of public favour. While alluding to the importance of adaptation to circumstances and surroundings, I should like to pay a tribute to those who have endeavoured —like Mr. W. A. Valon, of Ramsgate—to extend the use of gas in the houses of working men by the free provision of internal fittings and prepayment meters; for, while our friend the electric light may gain customers in the castle, mansion, or grand hotel, the more democratic element we purvey should make still more rapid progress in the workshop, warehouse, and cottage.

Perhaps I should say a word in reference to the growth of oil-gas manufacture and train lighting. The low price at which petroleum and paraffin oils are now obtainable, together with the steady improvement in various processes of manufacture, are all tending to the increased use of oil gas, both for enriching coal gas for general lighting and for carburetting water gas. In train lighting, since the paper I gave at Bristol,* constant and steady progress is being made, and oil gas is not only the light of the future for railway trains, but, to a large and rapidly increasing extent, the light of the present. Works are being erected and carriages fitted with gas at a steady and constantly growing rate; and even in Ireland, as will have been noticed by the description given by Mr. Outon at the North of Ireland meeting at Coleraine, of the new oil-gas works erected at the Inchicore works of the Great Southern and Western Railway,† very substantial progress is being made. There are, of course, differences in the views of railway companies as to the extent of their responsibility to the public, and especially to the third-class passenger, for providing a good reading light; and there are cases where the point of economy has been carried so far that they content themselves with merely giving a light

* See "Reports of Gas Associations" for 1892, p. 93. † See *ante*, p. 229.

which is a slight improvement on the old oil-lamp, with, of course, the advantage of permanence instead of occasionally burning down to a spark, and even at times going out altogether. I think, however, we may trust the onward march of improvement in the standard of railway comfort and efficiency to rectify these deficiencies, as the spirit that is leading to the provision of third-class sleeping and dining cars—where lighting, cooking, and warming is done by gas—will not allow a false economy to injure their prestige with their customers (when rivals are going forward), by restricting the light it is in their power to give. In addition to the lower price of the raw material in oil-gas manufacture, increased experience is lessening the cost of production, and leading to improvements in details of plant and methods of working, which only experience can suggest, and also in the prevention of nuisance from smell and smoke, which might be likely to cause interference on the part of the public authorities.

In conclusion, it may be interesting to those who have passed St. David's station, Exeter, on their way here, and noticed the oil-gas works now in operation at the Plymouth end of the station, to know that the building now utilized as an oil-gas works was once the engine and boiler house of the atmospheric railway which was provided for South Devon, and worked for a short time, until its unreliable character made this novel mode of travelling give way before the ubiquitous locomotive, whose speed and energy—like the light and warmth of the sometimes despised gas-jet—help to spread comfort, civilization, and peace over the face of the whole world.

Discussion on Mr. Stagg's Paper on the Manufacture of Gas.

The adjourned discussion on the paper read by Mr. W. Stagg (Bristol) at the previous meeting (*ante*, p. 74) was then taken.

Mr. N. H. Humphrys said that, to his mind, the paper presented several interesting points, which, he thought, they could discuss with great advantage. It especially commended itself, as being full of facts, the results of experiments. They saw, at the beginning of the paper, that "the following notes on the manufacture of gas are, to some extent, a record of attempts made to promote efficiency and economy of working." This explained, in a few words, the object they had in meeting together. They were all concerned in promoting the "efficiency and economy of working;" and, with this end in view, they found that Mr. Stagg had been taking a great deal of trouble

in observing what was going on, and had given them the results. Mr. Stagg's paper appeared to turn chiefly on two or three points. His experiments with regard to the evaporation of liquor in the hydraulic main were extremely interesting. His experience was not that of all of them; and it seemed to him that he must work the coal at a very considerable heat, and the retorts must stand some little time after the charge was worked, to get the gas so hot as to dry up the liquor contained in the hydraulic main. His suggestion with regard to the differential gauge was a very valuable one, and one that might be acted upon to a much greater extent than it was in gas-works. They had only to connect up their gauges, and commence with a full pressure at the exhauster, and, if they found the pressure going up (say) 3 or 4 inches, they had merely to go from one gauge to another to ascertain where the increase was. As to the question of the liquor in the hydraulic main, this was a matter in which he (Mr. Humphrys) had taken some interest; and the result of his experiments was that they had come down, not to single sections of hydraulic, but to short sections. In the paper, 40 retorts on one hydraulic were mentioned; but he did not care to have more than about 10 or 15 retorts. This saved the expense of an exhauster seal, bridge-valve, the connections, and so on, and secured all the advantages they could get with short sections. At Salisbury, with a make of 80 million cubic feet, they took up two beds at a time; and they only had the exhauster drawing on one or, at the outside, two—that was with some eight or ten dip-pipes. In smaller works, with one bed, it might be advisable to keep to the single section of hydraulic; but when they came to a scale of 50 or 80 millions, they obtained all the advantages of the short section, by connecting up to two or three beds. In that district, they washed out their hydraulics with liquor; and it was a great help to do this from time to time. Some of them emptied it off every 24 hours; but he thought it better for each to observe for himself what really was best—they could not have a general rule on this point. Regarding the testing of the gas at the outlet of the exhauster, it might be in the recollection of several of those present that Mr. Garnett some years ago described to them a similar arrangement to that referred to by Mr. Stagg, by which he obtained a test of the gas as it was actually being made. This was an important matter; for it immediately showed what gas was being produced. When they had large purifiers, and the gas took perhaps over an hour to pass through, if they were making foul gas, it would not be found out until that time had

elapsed. But if they had the jet photometer on the outlet of the exhauster, they would discover it at once. This was another matter of which they might take note.

Mr. F. G. Dexter (Winchester) said that, in attributing the loss of seal to evaporation (under the conditions subsequently explained), he had little doubt that the correct solution had been arrived at. But, while agreeing with Mr. Stagg on this point, he objected altogether to his experiments as being at all fitted to represent the conditions of working practice. It was essential, in making experiments intended to determine the operating causes and effects of ordinary working, that the conditions of the experiment should closely conform with the conditions of practice in every known particular. In this case, it was notably not so; and, in passing, he wished to mention the fact—which he believed to be fairly well known—that the true temperature of the gas was really not beyond about 150° Fahr., and that the higher figure that was given by Mr. Stagg of about 365° Fahr. was really due to the presence of finely-divided coal dust and tarry matter carried through the ascensions by the sharp up-current, and the influence of which on the experiment mentioned would be seen later on. Turning to the idea of the experimental flask, it was just possible that, through the thin glass, loss by radiation was to some extent promoted in the first experiment, although he (Mr. Dexter) certainly thought that, as in all probability the flask was placed close to, if not on, the hydraulic, these conditions more closely resembled the actual working than was latterly the case; for, by subsequently placing the flask inside the ascension-pipe, it became simply a question of determining the fact that the application of a hot current of gaseous and fine solid matter to the bottom of a flask would speedily cause evaporation of any liquid contents, altogether apart from the like, but much less active, tendency of a fine stream of gas bubbling through about an inch seal at the surface. There could be no doubt that, whether any stream of gas was passing inside the flask or not, the whole contents, under such conditions, would be rapidly lost, as Mr. Stagg succeeded in showing. A second fault in the arrangement appeared to be this, that, while by making connections to the active plant, the proper degree of "pull," &c., was ensured, yet there was no apparent indication that the relative proportions of the capacity of the hydraulic and ascensions had been repeated by similarly repeating the proportions of the tubes of the flask to the flask itself. The one acted as the ascension and dip, and the other as the hydraulic. In summarizing, Mr. Stagg

admitted that the evil became intensified directly the one lot of ascensions became choked; thus throwing the greater part of the entire work on the one hydraulic of the other side. Therefore, disproportioning the flask and tubes would have at once introduced an element of uncertainty. One lesson to be learnt from Mr. Stagg's experience was the undoubted advantage of having all the hydraulics and their mountings of ample size. He (Mr. Dexter) had recently very much enlarged the hydraulics, &c., at Winchester, with very beneficial results He also bore testimony to the great value of running not only a small stream of liquor constantly through the hydraulic, but having ample means of completely flushing out with liquor in large volume at intervals. His hydraulics were now arranged to discharge the whole contents instantly to the wells; and further, by means of an overhead tank and two 2-inch discharge-pipes from it, to rapidly scour out the hydraulic with great force direct to the wells. No deposit could remain; and, after twelve months' working, the hydraulics were as clean as when first erected. In arranging the overhead tank, he (Mr. Dexter) felt a certain risk in applying a gauge, as suggested by Mr. Stagg. It was quite possible a man would not be there when the tank was charged, and a certain blowing away of the gauge would result. He had instead put in an air-valve which instantly closed the moment the tank was full. The connections for filling were attached to the circulating-pump to the scrubber; and the moment the increased resistance occurred (due to the valve closing), the pump simply delivered on up to the scrubber distributor. Passing to the question of gauges, he might say that the differential arrangement was very useful; but, from experience, he considered intermediate gauges on the connecting mains just as necessary. Stoppages were as likely to be found there as in any apparatus. The information given under the head of carburine was very interesting; but he thought the experimental work again unfortunate. The determination of whether or not coal gas with added carburine lost any virtue at freezing temperature would be best made by photometrical work rather than the question of deposit in tubes. It appeared to be quite possible that, at very low temperatures, as at high temperatures, carburine might undergo some change though not necessarily a detrimental one. However, whether the deposit possessed interest from the photometrical standpoint or risk of interruption of supply, the practical value of the experiment was at once discounted by the abstraction of the water vapour with calicum chloride. With regard to photometrical value, it had

already been placed upon record that dried or desiccated gas possessed a higher lighting value than the commercial article; and he believed patents had been attempted for applying gas treated in this way for special cases of lighting in confined spaces. It had also been clearly proved that water vapour played an important part in causing deposition of the heavier hydrocarbons at low temperatures. For instance, naphthalene deposit was very often brought about by the deposition of water icicles; and the frequent deposit of this troublesome matter in outside lamps had been completely stopped by first drying the gas at the foot. Consideration of these facts would clearly show that the removal of the water vapour had robbed the experiments of all useful indications as bearing upon the essential conditions of practice.

Mr. S. W. DURKIN (Southampton) said he had not had similar experience to Mr. Stagg; but he might state that, from observations he had made, they had, in through settings, according to the temperature caused by the direction of the wind, very frequently a large volume of gas passing through one hydraulic and very little through the other. The point regarding evaporation was, however, quite new to him. He hoped that, if anyone had a similar experience to Mr. Stagg, he would have the matter investigated, and some test applied, with the view of preventing the recurrence of such a thing.

Mr. H. SAINSBURY (Trowbridge) said he did not know whether many of the members had in use the arrangement of photometer on their exhauster to which Mr. Stagg had referred. He happened to have a photometer and purifier, as suggested by Mr. Garnett, and also a jet photometer with a regulator, so that he could see how the gas was burning, and the men could ascertain, and avoid getting nearly an hour's bad gas through before it would be otherwise found out. He had a case only a week or two previously, when he was putting in a new bed of retorts. The seal was not quite right, and consequently it drew in a little air; but he was able to get over the difficulty before it had in any way affected the gas which had already been passed into the holders. Without this arrangement, he would have had some 5000 or 6000 cubic feet of bad gas mixed with all his good gas.

Mr. DURKIN asked to be allowed to say that he was still persevering with the air process in connection with their purifying system at Southampton, and one of these arrangements of a small purifier and a jet photometer on a certain occasion came to their relief, and enabled them to immediately stop some mischief

that was going on. Where the air process was in operation, this little sentinel in the exhauster-room was very necessary, and would frequently prove useful.

The PRESIDENT, like Mr. Durkin, had not, so far as his experience had gone, been confronted with much of the difficulty Mr. Stagg had had to battle with; and he had little doubt as to whether, in any well-proportioned works, the trouble would be one that frequently occurred. He would illustrate this by referring to two works, where they had practically the same seal in each instance. He believed Mr. Stagg had not told them the exact amount of seal in his case; but, working with an average of about ¾-inch seal in these two works, in one they occasionally found the seal had been uncovered, but in the other they had been doing what had often been talked about at their meetings—that was, they had raised the hydraulic mains so as to remove them from the radiating influence of the retort-bench, and in that way obtained increased length of ascension-pipe. This had resulted in giving them comfortable working; and no question such as that alluded to by Mr. Stagg had arisen.

Mr. PADFIELD said he had not had the trouble mentioned by Mr. Stagg with his hydraulic mains at the Exeter Gas-Works. There had been times when the illuminating power of the gas had gone down very much; and he had found that it had been wholly due to the great increase of temperature up to a given point in the works. He thought the suggestion Mr. Stagg had made was one worthy of consideration. As to enriching gas, this was a very important question indeed; but he should like to have a few details as to the relative cost of raising the illuminating power of the gas one candle by cannel and carburine.

Mr. STAGG, in replying to the criticisms, said that Mr. Humphrys found fault with the number of retorts that had been led into one hydraulic. But he had had to deal with things as he found them; and he had given the number 40 as being an extreme case in their works. The hydraulic mains, however, were now being divided into two. Mr. Dexter agreed with him as to the results, but not in the methods by which he had arrived at them in some cases. He had referred to the drawing of the hot gas through the flask as not being in conformity with the conditions of practice. He (Mr. Stagg) saw this at the time; but it was the nearest he could get to them. As regarded the hot dust, that was a new matter to him; and it might be worth following up. But he thought something more than dust was required to reach such high temperatures as he had obtained.

Mr. DEXTER (interposing) said that he believed Mr. Newbigging had once carried out some experiments, by placing a series of fine wire gauze screens in the ascension-pipes, and at the back of these he inserted thermometers, in order to determine the temperature of the gas. It was found that the moment he introduced a screen with a mesh sufficiently small to cut off the fine dust bound up with tarry matter which was passing up the ascension-pipe, the screens were very rapidly coated; but, as soon as they were removed, the thermometers registered a high temperature by these small particles sticking on to them.

Mr. STAGG (continuing) said that what he wanted to show was that the slight lowering of the seal on one side led to rapid evaporation, from whatever cause it might be, in the hydraulic. With reference to the differential gauge, he was told that they ought to have an ordinary gauge in addition. If they looked at his sketch, it would be noticed that he put one in at the beginning, which showed the pressure at the outlet of the exhauster. As regarded the carburine, the tests were made with a photometer. The gas was passed through calcium chloride, to show that it had no effect upon the carburine. His object here was to determine whether there was any deposition from the cold. There was no doubt the lower temperature would affect the gas, and would affect the carburine in the same proportion as it would the gas, even if there was no deposit. What he was trying to find out was whether there was a deposit; and there was not until it got below freezing point. In regard to the cost of carburine, he did not actually know the figure; and he could only say as he put it in his paper —that it practically resolved itself into "the difference between the extra cost of cannel over common coal against the cost of the carburine." Of course, if cannel coal was to be had very cheaply, there was no advantage directly in the use of carburine. There was, however, a distinct advantage in this way—that they could always be sure of not making gas of a better quality than they were obliged to do; and, if it happened to be a little lower in illuminating power than it ought to be, it could be raised in three or four minutes.

Mr. DURKIN then read the following paper, entitled—

NOTES, ETC., ON MAIN LAYING.

In a moment of weakness, I volunteered to give this meeting a few notes on main laying; but, as most of you know all about this branch of service, it looks like getting up to talk out the time. In Southampton a wave of commercial prosperity has

lately set in, which has tended to increase the demand for gas; and, although there is some electric lighting in the town and the docks, yet at present it has not caused my Directors to hold their hands in discharging obligations to meet the gas requirements of the district. This means the enlargement of the producing power and district mains; and this has been going on gradually for some time past.

A short description of our district may give you some idea how "octopus like" our mains have to stretch out to secure our prey. The town proper stands on a point of land—on the West bounded by the River Test, and on the East by the River Itchen, on the banks of which our works are situated. From the works we have three sets of mains running out—one set supplies the town proper; the second goes north, then eastwards to the suburbs in that direction; and the third, a 24-inch main, is taken up to a central part of the upper town, from which lateral mains diverge to the western suburbs. From this 24-inch main, I derive the text for my notes. From the end of the main in a northerly direction after leaving the town, we pass through some important residential suburbs; then into the open country; and, at about 5½ miles distance, we come to what is getting to be an important place—viz., Eastleigh—where the London and South-Western Railway Company have established their carriage works. To cope with the demand at Eastleigh Junction, the works named, and the external demand in the township, my Directors, under the advice of my esteemed friend Mr. J. Birch Paddon, determined to complete a contemplated enlargement from the 24-inch trunk main. The responsibility of carrying out the work was placed in my hands. I have had heavier work of the kind to perform, but have usually managed to drive the trunk mains without having them charged. In this case I had about 700 yards of 18-inch main to lay, and the same quantity of 14-inch to lift; and every night I had to connect up to supply the district beyond. Previous to starting, all details had to be well considered, in order to carry out the work successfully, as the road was a busy thoroughfare, and the tramway was close to us for the major part of the distance. To facilitate the temporary connecting up at the close of each day, I sketched out a plan to use two wrought 9-inch pipes, with an iron plate at each end, to be made gas-tight with india-rubber rings tightened up by screws with wing nuts. The centres of the two wrought pipes were to have been connected up with a piece of rubber hose; but this device to save time was, like other schemes of mice and men, frustrated by the manufacturers being

totally incompetent to be up in their deliveries. I expect Belgium or Germany would have done better. However, an 18 in. by 9 in. taper pipe, with a shallow lead joint at one end, and a modification of the original plan made at home, did duty at the other or 14-inch end every night.

The longest days had to be made the best use of; and everything that would save time was pressed into service, especially as we could only open up comparatively short lengths of ground, so as not to inconvenience the traffic. Here I found the pipe extractor invented by Mr. J. W. Helps, of Croydon,* of the greatest service. The bags having been inserted in the usual way, this instrument was set to work, and very expeditiously disjointed the pipes, with no waste in the spigot or squaring up spawled ends before the 14-inch pipes were relaid later on. In fact, time was saved all round; so that I cannot speak too highly of the service rendered by this simple arrangement. The lifting two 9-feet lengths of 14-inch pipes out of the trench was performed by a tripod, with a sprocket wheel Weston pulley block, which was also used in lowering the 18-inch pipe into position. This arrangement I have found very useful when laying larger mains in the district.

I commenced breaking ground on the 26th of June; and the whole work was completed, and a double connection to two mains made, by the 22nd of the next month. Our average rate per day was 32 yards—some days more, and some days less. Just as we were nearing completion, a sudden thunderstorm broke over the town, with a tropical deluge of rain, which rose in the trench somewhat alarmingly—indeed, we had a very narrow escape from a catastrophe, as some of the joints were open; but the storm was of short duration and this was averted. This is the third main I have seen laid in the same trench at intervals during the past forty years, to meet the demands of a portion of the community we have to serve.

Discussion.

Mr. WILLEY inquired if the pipes referred to were turned and bored; and also the depth at which they were laid.

Mr. HUMPHRYS said that in these days of cooking and heating stoves, gas-engines, and other appliances for daylight consumption, this question of enlarging and relaying gas-mains acquired increased importance. At Salisbury, they had recently to take up about a mile length of 3-inch pipe, and replace it

* For a description of this appliance, see *Journal of Gas Lighting*, Vol, LII., p. 508; and Vol. LIII., p. 117.

with a 6-inch one; and on that pipe they had several consumers who used gas for cooking and other purposes, with whose supply they did not wish to interfere. The means by which they effected this was by laying as many pipes as they could in a day—say, ten or twelve—and making up a temporary wrought-iron connection with a hole bored in one side of the pipe and another in the line laid parallel to it. They began first by inserting a T-piece at the end of the main; and, having got that in, they did not interfere with the supply again until they made the connection at the other end. They first broke the connection, and then proceeded to lay down twelve more 6-inch pipes; and at the end of the twelfth one, they drilled two holes and made up with a piece of 2-inch wrought-iron pipe. They had a corresponding length of 3-inch pipe left; and they broke that out, and stopped it off just at the other side of the 2-inch connection. Several of the street lamps were not alight at the time; but there were no complaints of shortness of supply from consumers.

Mr. J. Lowe (Weymouth) referred to two or three instances of new main-laying work which he had carried out; but he said he had not experienced any great difficulty, or, by keeping both mains alive, occasioned any inconvenience to consumers. He had a little trouble some time back when laying an 18-inch flange pipe under water. The work had to be done at low tides; and when the water came in, it washed in a good deal of sand.

Mr. Padfield agreed that the plan of keeping the mains alive was no doubt the right one. He had had to put down a 15-inch pipe on one side of Exeter; and they done the work pretty expeditiously. Before laying a pipe of this kind, it was best, where there were sewers and electric light and other pipes, to open up a trench for some distance, so as to see where they were going. Wherever he possibly could, he laid the pipes in the footpaths; and this resulted in a saving of labour, a lessening of leakages, and other advantages. The great aim he had was to reduce the amount of leakage. About 21 years ago, they had in Exeter something like 28 per cent. of leakage; and now it was a little more than 5 per cent. The plan they had adopted during the last ten or twelve years of laying the mains in the footpaths, pitching and placing the services in troughs, using the best material, and taking great pains, was the one to produce the best results in the end.

Mr. Lowe wished to add to his remarks that his experience was that the pitching of mains was a very "ticklish" operation to do successfully. If the pitch was a little too hot, and it

blew, forming small air bubbles, it tended rather to the destruction of the pipe than to the extension of its life. If the pipe was wet, too, the pitch would not adhere; and it would be very rapidly destroyed. He had abandoned pitching altogether. Tar being a drug (they had only a small sale), they had adopted the plan of mixing it with breeze, and laying the pipes on a bed of that. They then drenched them with tar, and covered them up with tar and ashes. In laying an old pipe for temporary use some forty years ago, he had adopted this expedient; and, to his astonishment, some ten years later, he found the pipe was still perfect.

Mr. DEXTER stated that he recently had occasion to lay close upon a mile of 8-inch main; and in its course he had to pass over two old bridges (dating back three hundred years), the stones of which were of great depth. The old main passed over the crown of the bridge, with a covering of only 2 or 3 inches of soil—a condition of things that led to difficulties in the winter. In laying the new main, he had two complete courses of the stonework taken out of the crown; leaving the bridge in two sections. He then built across the bridge some 16-inch pipe to act as a sort of tube, through which the main was laid. It was heavily jointed with lead, and slung up to the stone arch by wrought-iron bands at frequent intervals. They then passed the main through, and packed it with sawdust, and securely closed up the ends. This had completely overcome the deposition of naphthalene through exposure. He also bore testimony to the extreme usefulness of Mr. Helps's pipe extractor, to which Mr. Durkin had alluded.

The PRESIDENT, referring to the covering of pipes, said he had adopted for some time now the practice of laying them in troughs, and covering them with pitch. He was that day commencing to lay two miles of high-pressure oil-gas mains at Bristol; and they were using what was known as Perkins's pipe with the V end on to the flat end of the other pipe. The left and right hand thread socket drew the V-shaped edge into the flat end of the pipe; and they could in this way be joined up so as to stand a gas pressure of 200 lbs. without leakage. They were placing the pipes in troughs, the wood of which was dipped in carbolineum, and the whole was covered with liquid pitch. They had had some of these mains in use from five to seven years; and when they had been making alterations, they found they were still perfect.

Mr. DURKIN, in replying to the discussion, said that the pipes referred to in his paper were not turned and bored; they were

open lead joints. With regard to the depth of the pipes, in his district the frost entered the ground quite a foot; and, if he were opening up a new road, he should lay his pipes 2 feet underground. In the case to which he referred in the paper, one part of the main was quite 4 feet deep. Some two or three years ago, they had to carry a line of pipes over two iron bridges. One was formerly a wooden structure; and the main (which was a 9-inch one) was laid on one side of it on cantilevers. Now this pipe was not covered up; and it might interest the members to know that, wherever the pipe was exposed, they never had any trouble by the deposition of naphthalene; but at the entrance and exit of the pipe, where it was laid in rather cold and damp ground, they had frequently to remove this substance. When the bridge was re-built, they carried a 14-inch pipe across it. There was a place provided for it on the structure itself. The pipe which they used was one that was largely employed in colliery districts. About 4 inches from the spigot end, there was a fillet cast on; and the bead end of the spigot was raised to receive an indiarubber ring. The spigot end being passed into the socket, it was forced in; and the rubber ring was flattened and rolled until the end of the spigot was bedded up to the back end of the socket, and the fillet prevented the ring coming out at the front. This had been in operation some three years; and there had never been any leakage or disturbance.

A vote of thanks was then accorded to the President, for the able way in which he had conducted the duties of his office; and the proceedings concluded.

EASTERN COUNTIES ASSOCIATION

HALF-YEARLY MEETING, SEPT. 13.

This Meeting was held at Melton Mowbray. The members assembled at the gas-works, where they met with a very cordial reception from the Directors of the Melton Mowbray Gas Company. The works, which had been under the care of Mr. T. Greaves for some 25 years, were found to be a model of neatness; every part of the plant bearing testimony to the careful attention bestowed upon it. The annual output at the time of the visit was about 24 million cubic feet; but the principal portion of the works had been laid out to produce up to 100 millions, with very little extension. Some fourteen years ago, a new retort-house and gasholder were erected. The former is a spacious building; and in it the visitors saw two huge stacks of coal, which would carry Mr. Greaves well into November—a position which must have been coveted by several of the gas managers present whose stocks, owing to the then prevailing great dispute in the coal trade, were beginning to cause them some uneasiness. Having been conducted round the works by the Chairman (Mr. G. Fitton) and Mr. Greaves, the members proceeded to the Collis Memorial Hall, where the business was transacted.

The HON. SECRETARY (Mr. H. Wimhurst, of Sleaford) read a letter which he had received from the President, Mr. W. Duesbury, of Cambridge, informing him that, through a serious illness, he would be unable to attend the meeting.

On the motion of Mr. W. BARRATT (Grantham), seconded by Mr. GREAVES, Mr. C. E. Jones (of Chesterfield), was requested to preside.

Mr. JONES, having taken the chair, said he was sure Mr. Duesbury would accept from him, as the mouthpiece of the meeting, their heartfelt sympathy with him in his affliction, and their most fervent hopes for his speedy recovery.*

* Mr. Duesbury, who was suffering from an affection of the heart, was found dead on the following Sunday morning at the house of his son in Cambridge.

A Welcome to the Town.

Mr. Fitton said he wished to take this opportunity of assuring the members, on his own behalf and that of his co-Directors, that they had the greatest pleasure in welcoming the Association to Melton Mowbray. They had not much for the members to see; but they could show them a very neat and compact gas-works.

The Chairman, in reply, asked Mr. Fitton and his colleagues to accept the hearty thanks of the members for the kindness they had manifested to them that day. He said he must add that better organized and cleaner works devoted to the manufacture of gas he did not remember having seen.

New Members.

Mr. C. J. N. Row, of Long Melford, and Mr. G. Eraut, of Braintree, were elected members.

Mr. J. G. Hawkins (Spalding) then read the following paper on the

PURIFICATION OF COAL GAS.

Gas purification may justly be considered one of the most, if not the most, important branches connected with the gas industry. It is of the utmost importance that the gas supplied to the consumers should be perfectly pure, lest the products resulting from combustion should be such as to vitiate the air, and render it injurious to health. The impurities present in ordinary crude gas may be enumerated thus: Carbonic acid, ammonia, sulphuretted hydrogen, and bisulphide of carbon. There are other impurities; but these need not be considered on the present occasion.

Carbonic acid has the effect of reducing the illuminating power; 1 per cent. of it reduces the amount of light by 6 per cent. Ammonia exerts a corroding influence on brass and copper fittings. Sulphuretted hydrogen is perhaps the most obnoxious of all the impurities, chiefly because of its disagreeable odour in case of leakage and the rapidity with which it tarnishes bright metal, gilt mouldings, as well as silver plate. Bisulphide of carbon, when burning, produces sulphurous acid, which by exposure to the air rapidly changes to sulphuric acid, and which together with any moisture present is deposited on the furniture, books, mouldings, and paintings that may happen to be in the room where the gas is being consumed, having a very deleterious effect. How, then, these impurities may best be removed, is what we have to consider.

It may be taken that purification begins at the hydraulic

main; but, for our purposes, we need go no further than the inlet of the condensers. The temperature of the gas at the inlet of the condensers is usually about 130° Fahr., according to the number of retorts at work and their situation. The temperature at the outlet of the condensers should be about 60° Fahr. By this cooling process, all tarry and aqueous vapours held in suspension are thrown down as liquid tar and water respectively. It is well known that water in a fine state of division rapidly absorbs ammonia and sulphuretted hydrogen, and that ammonia combines with carbonic acid. This being so, it follows that too sudden condensation should be carefully avoided, lest the aqueous vapour is thrown down before it has had sufficient time to become charged with these impurities. It is desirable, therefore, that the condensers should in all cases be in proper proportion to the make of gas, and on such a principle as to render too sudden condensation impossible.

The next stage we come to is the scrubber. Why it is called a scrubber I do not know; as that name, to my mind, conveys a very erroneous impression of its real object. There should, however, never be less than two of these so-called scrubbers, no matter how small the works are—the gas entering first through one and then through the other. The first should be supplied with a continuous stream of ammoniacal liquor; and the second with a continuous and carefully regulated stream of clean water. The first scrubber will eliminate the bulk of the remaining ammonia, in combination with carbonic acid and sulphuretted hydrogen. The second scrubber, being supplied with clean water, will completely remove all remaining traces of ammonia, as well as a small quantity of carbonic acid and sulphuretted hydrogen.

We now come to the purifiers proper. The impurities that have to be eliminated at this stage are the remaining traces of carbonic acid, sulphuretted hydrogen, and bisulphide of carbon. In towns where the gas authorities are not compelled by Act of Parliament to remove sulphur compounds other than sulphuretted hydrogen, the elimination of the bisulphide of carbon is not of importance; and in those cases oxide of iron alone might be used. But where the authorities are compelled to keep the sulphur compounds within prescribed limits, the removal of the bisulphide of carbon is essential; and this necessitates the employment of lime. Some engineers prefer to use both lime and oxide—placing the lime first, with the object of removing the carbonic acid and the bisulphide of carbon; and the oxide last, for arresting any traces of sulphuretted hydrogen. Others,

doubtless on account of economy, are content to use oxide of iron only; and in such cases, of course, sulphuretted hydrogen is the only impurity dealt with. I have found that the best way to use oxide of iron is in layers of 1 ft. 6 in. deep; two layers in each purifier. I have purified more than 100 million cubic feet of gas with one single change of purifier when using oxide of iron. The oxide was new when put into the purifier; and, when taken out, it contained 50 per cent. of free sulphur. These results were obtained with the atmospheric air process, introduced by myself some few years ago, and which I explained in a paper read at a meeting of the Manchester District Institution of Gas Engineers.* The process is continuous, and offers great advantages where oxide alone is employed.

At the Spalding Gas-Works, of which I am Manager, I have recently been making some experiments with regard to gas purification with lime. These experiments are as yet far from complete; and, as a consequence, I am unable at this meeting to give you all the information I should like respecting it. Our annual make of gas is 22 million cubic feet; and our purifying plant consists of four purifiers, 8 feet square by 3 feet deep. Previous to the commencement of my experiment, it was usual to change three purifiers every fortnight in the winter, and an average of two every three weeks during the summer. I commenced my experiment on the 10th of May (just four months ago), when I had the usual two foul purifiers and one clean one. I began by introducing a carefully regulated quantity of atmospheric air into the gas at the inlet of the condensers, amounting to 2 per cent. Two days later, I found that I had only one foul purifier and two clean ones; and for a week we remained stationary in that position. I then increased the atmospheric air to 2½ per cent., with the result that two days afterwards I had no foul purifiers whatever. We continued in this position for a whole week, carefully noting the quality of the gas the whole time. I then shut off the supply of air; and within a few hours the first purifier showed traces of sulphuretted hydrogen. In three days it had got decidedly foul; and the No. 2 purifier also showed traces. I then re-introduced the air as before, with exactly the same result, which I have repeated many times. At present, all our purifiers are clean—not one showing the slightest trace of sulphuretted hydrogen.

The quantity of gas made from the commencement of the experiment up to now is 4,208,000 cubic feet; and during this time there has been no change of purifier whatever, and the

* See *Journal of Gas Lighting*, Vol. XXXV., p. 408.

purifiers that were foul at the beginning are now clean. The illuminating power of our gas is about 17 candles, which has, if anything, been slightly improved during the experiment; and our make of gas per ton of coals carbonized will average close upon 11,000 cubic feet.

Thinking it would be of interest to the meeting if I abstracted a sample of the material from the first purifier, I have just had that purifier shut off, and a sample taken therefrom. On analysis, it will be found to contain 29 per cent. of free sulphur. It is perfectly inodorous; showing clearly, therefore, that it has a considerable commercial value, and must no longer be looked upon as waste, nor to become a nuisance. I have also brought with me some sulphur obtained from 100 grains of the material taken from the sample now before you.

In working upon this system, great care must be taken to keep the percentage of air constant, and in regular proportion to the make of gas. As the make of gas varies, so must the quantity of air vary accordingly. This can only be accomplished by some suitable contrivance working in combination with the station meter. Such an arrangement is in operation at the Spalding Gas-Works.

My experience of lime and oxide purification up to the present is decidedly in favour of the former; it being, in my opinion, the better purifying agent of the two, and more economical.

Discussion.

Mr. GREAVES said he noticed that Mr. Hawkins worked with layers of 1 ft. 6 in. thickness in his purifiers; but he found, from practical working during the past 14 years, that from 3 to 4 feet layers of oxide of iron were preferable. He had previously tried lighter ones; but they were not sufficient to properly perform the work required of them, and therefore he increased them in thickness according to the depth of the purifiers. With respect to the difference between lime and oxide of iron, his experience of the latter for something like 16 years was that it was quite equal, both in regard to economy and purification results, to the use of lime alone, by finishing off with lime in the last box. With reference to the admission of air, he had been working on this system for the past four years; but while the author of the paper only gave 2½ per cent. as the extent to which they should go, he had gone as high as 3½ per cent., without deteriorating the illuminating power of the gas. He never on any account supplied gas of less than 18-candle power (he was told that it was that day registering 20 candles); and in the winter months it went up to 22 candles. As Mr. Hawkins

stated, it required a great deal of experience to pass in the proper proportion of air to the quantity of gas being made. He admitted the air at the same point as Mr. Hawkins—on the foul main, before the gas reached the condensers. The admission of air was a great improvement in the purification of gas. He had not changed his purifiers since May 6, and would not have to do so before the end of October.

Mr. F. WELLER (Southtown, Yarmouth), as Manager of a small works, making about 14 million cubic feet of gas, said, when he heard papers read like the present one, it made him wish that he could change his purifiers a little less often. He only used lime, and had three purifiers, 8 feet square, and 3 feet deep, in each of which he had four layers. He should like to be informed how Mr. Hawkins regulated his air supply.

Mr. J. BARTON (Peterborough) said that the subject under consideration was a most important one. At his works he had had a patent process in operation for about twelve months. He did not like the idea of drawing in air by the exhauster in a random sort of way; so he had special plant put down for drawing in the air and carburetting it at the same time. He had found very great benefit from this system, without injurious effects on the illuminating power of the gas. Using very much the same kind of coal during the past twelve months as previously, he had not had the slightest difficulty in keeping the illuminating power up to 17 candles in the winter, and a little above in the summer. He did not go so far as Mr. Greaves, but adjusted the air to as near 2 per cent. as possible on the make of gas. It was most important that the percentage of air should be uniform. If too much was admitted, it did considerable harm; but the right quantity did a great deal of good. He had worked with two boxes of oxide of iron, and one partly filled with oxide, with merely a top tier of lime; and sometimes he did not use lime at all. The difficulty which he experienced was not so much in keeping the purifiers clean, as the back pressure. He did not know how he should go on if he employed, as Mr. Greaves did, 3 or 4 feet of oxide. He never used more than 18 inches, and had to reduce to 16 inches, in order to get the purifiers to do the work he expected of them. He had to change his purifiers, not because they were dirty, but because they gave him back pressure. The last purifier changed had passed something like 21 million cubic feet of gas; and one of the present purifiers had passed more than 25 millions, but he found the back pressure was beginning to increase. He was afraid if he added to the thickness of the oxide, he would not

be able to pass anything like the quantity of gas he was now doing. He had no difficulty in putting something like 55 per cent. of free sulphur in the oxide. As to the percentage of air, he quite agreed that it should be kept constant; and if some scheme could be devised to adjust and keep it at the right amount, he believed that gas purification would be pretty well complete as regarded bisulphide of carbon.

Mr. A. DRAGE (East Dereham) remarked that at his works he used oxide of iron first and a catch lime purifier afterwards. The oxide was in 18-inch layers; but he found that the inlet bottom tier became very hard, and this threw a tremendous back pressure on the exhauster. The oxide in this bottom tier was much harder when the amount of "pull" on the exhauster had drawn air into the purifier.

Mr. BARRATT said there was no question that this was a very suggestive paper; but it was surrounded by a number of incidents that had not been brought out. It was essential that they should know, first, something as to the author's condensation; second, with regard to the scrubbing; and, third, the state of the gas before it went into the purfiers. It would be patent to everyone that, if they had condensers and scrubbers that were not doing their work efficiently, the gas must be in a very different state when it entered the purifiers than it would be under other circumstances. In his own case, he used lime only; and it would have been better if Mr. Hawkins had worked out for them the difference between the cost of purification by oxide of iron and by lime. After all, it was a matter of £ *s. d.* He (Mr. Barratt) could buy lime at a fair price, and get a fair price for his spent lime. Perhaps Mr. Hawkins and Mr. Barton could not do this; and therefore it would be cheaper for them to use oxide. With regard to the statement that some engineers used lime first rather than oxide, he could scarcely understand this, because his reading and observation showed that oxide was generally used first and the lime last, in order to take out any carbonic acid there might be in the gas. However, he was of opinion that condensation and scrubbing had very much to do with the purification of gas, and a great deal more than some gas managers gave credit for; because, if the condensers and scrubbers were very efficient, of course the purifiers would have less to do. When he first went to Grantham, he had five condensers, composed of 8 or 10 inch pipes. These were all right in the winter, but in the summer he had more condensation than was wanted; and he had no means of checking or altering this. The condensers

were connected by a pipe, at the top of which there was a plate. He took off the caps, and introduced a 2-inch pipe from the top to the bottom, and screwed it into the flanges, and made them secure. He found this very efficient; and it improved his condensation to such an extent as almost amazed him, and the purification came down nearly 40 per cent. With regard to the scrubbers, if they were efficient, much stronger liquor would be obtained than would otherwise be the case.

Mr. BARTON here mentioned that at Peterborough, the cost of purification during the year ending June 30 last was about 0·3d. per 1000 cubic feet of gas sold.

Mr. J. CARTER (Lincoln) questioned whether Mr. Hawkins really meant what might be said to be the fair interpretation of the statement he made with regard to the removal of sulphur compounds other than sulphuretted hydrogen in those places where no statutory restrictions were imposed—that the matter was not of importance. Taking a broader and more general view of the question, he thought it was an important one; and it was extremely necessary that all gas managers should get the proportion of sulphur compounds down to as low a point as possible. His experience had convinced him that the exclusive use of oxide, even with the provision for atmospheric air, was not a completely satisfactory method of purification. The figures Mr. Barton had given them were exceedingly suggestive; and it was a very advisable position to get into, if they could accomplish their purification at ½d. per 1000 cubic feet of gas sold. In his own case, he found that, to get the sulphur compounds down to an average of 14 or 15 grains per 100 cubic feet of gas, he could not do his purification under something near ¾d. per 1000 cubic feet of gas made. There were two reasons why he discontinued altogether the use of oxide. When spent oxide could be sold at from 4d. to 5d. per unit, certainly there was more inducement to use it than under the condition that had obtained lately, when, if they realized 2d. per unit for the spent material, they had done very well; and they were also confronted with the chronic difficulty of accumulating a large quantity of foul material on the works. He believed lime was the safer and better material to use in the purifiers. He was indebted to Mr. Hawkins for having read this paper, for it had reminded them of the possibility of using lime, and rendering it inoffensive and inodorous by the admission of a small proportion of air.

Mr. HAWKINS, in reply, said that he agreed with Mr. Greaves as to the importance of having plenty of purifying area; but he

thought that, as a rule, 18-inch layers would be found quite sufficient. He would not like to say that, by increasing the thickness, the purifiers would run longer, because then they might have to contend against back pressure. As to the adjustment of the air supply, he had a very simple and accurate arrangement coupled up to the drum-spindle of the station meter. He had a wheel which worked into the first wheel of the station-meter drum-shaft, and to this he had a counter-shaft that coupled up a 30-light wet meter; so that, at whatever speed the station meter was working, the wet meter, being set to a certain proportion, must keep in constant proportion with it. If the station meter passed (say, for example) 100 cubic feet of gas in one hour, and he wanted to admit 3 per cent. of air, the wet meter would send in 3 feet; and, if 1000 feet of gas was passing, then 30 feet of air would be sent in. If he desired to admit 4 per cent. of air, then he simply had to increase the size of the driving-wheel. He ought perhaps to say that, with a great percentage of sulphur in the coal, they would need a little more air; but, having ascertained the quantity, it must be kept uniform. With reference to Mr. Drage's remarks, he suggested that he should place a layer of 2 or 3 inches of breeze on the bottom tier; and this would take out the moisture in the gas, which no doubt caused the clogging, and would allow the gas to pass through comfortably. As to the cost of lime compared with oxide of iron, he contended that the purifiers at Spalding cost him nothing, because, at the commencement of his experiments, he had two foul purifiers and one clean, and now they had not the former. Of course, he did not mean to say they would last for ever. He agreed with Mr. Barratt that it was important the condenser and scrubber should be quite equal to the requirements, as there was no doubt a great deal of the purification was done silently in those vessels. Some people did not agree with the idea of washing gas with ammoniacal liquor to any serious extent; but he found great advantage from it.

Mr. GREAVES said he would like to add to his remarks that he had found the hardening of the oxide to which allusion had been made, was due to having too much moisture in the material itself. Mr. Hawkins had stated that the cost of his purification was "nothing." He had gone even farther than that; for, as his books would show, they had made a profit on it. It would be found that 1 ton of new oxide would make 2½ tons by the time it was ready to send away. For the new oxide, he had to pay £1 12s. 6d. per ton; while for the 2½ tons of spent oxide he obtained £1 7s. per ton.

Mr. HAWKINS also added that spent lime, containing 29 per cent. of free sulphur, would be worth (at 4d. per unit) from 12s. to 14s. per ton.

The CHAIRMAN, in concluding the discussion, said there was no doubt whatever as to the propriety of having the condensing and scrubbing apparatus in proportion to the purifiers; but one point that appeared to him to be lost sight of was the velocity at which the gas travelled through the purifying material, which must of necessity be more or less dense. The lighter it was, the easier would the gas pass through; and the denser it was, the greater would be the back pressure. It also necessarily followed that, if they had a large area, the gas would pass through the material at a low velocity; and, with only one-half the area, it must always go as fast again. The broad question of area (which possibly was not raised in the paper so much as it might have been) was one which should receive more attention than it had done, as it was the long-continued contact of the impurities that they desired to eliminate with the purifying material which rendered efficient any system of purification. It was quite true that purification of the gas commenced at the hydraulic main, and ran right through until it reached the purifiers. He held that the purifiers should be simply the finishing vessels. They were learning more and more about this question of purification; but they were not yet thoroughly versed in all those wonderful changes which took place in the purifying apparatus. He hoped the time would come when they would know a great deal more about them. He proposed a cordial vote of thanks to Mr. Hawkins for his paper.

Mr. WIMHURST seconded the motion; and, in doing so, mentioned that he was at Spalding a short time since, and saw Mr. Hawkins's apparatus there before he had it so complete as at present. He then found that the first purifier only showed a small trace of sulphuretted hydrogen; and the other two were perfectly clean. He was so convinced of the desirability of admitting air in the purification of gas with lime, that he intended to increase the amount they had been passing, which was only about $\frac{1}{4}$ to $\frac{3}{4}$ per cent.

The CHAIRMAN observed that his experience of air purification in combination with lime and oxide was that, if $1\frac{1}{2}$ per cent. was exceeded, then they got beyond the dangerous limit. He was surprised to hear that some members used 2 per cent. and upwards; and, furthermore, he was astonished at the statement that it had no effect upon the illuminating power of the gas.

The motion was carried by acclamation.

Mr. W. H. MANWARING (Lincoln) next read a paper on

GAS-COOKERS.

In submitting a paper on this subject to your Association, I am well aware that it is unnecessary for me to advocate the general policy of inducing additional consumption of gas by this or any other means. Whether the increase is to be obtained in the direction of lighting, heating, or power, we are well agreed as to the desirability of selling more gas each year than we did in its predecessor; and it is a comfortable fact—predictions to the contrary notwithstanding—that this hope is in most cases realized. Gas as yet stands pre-eminent as the popular lighting agent; and it is advancing steadily into very respectable rivalry with steam as a source of power.

On the score of economy, we need not expect gas-fires to supplant coal, except where intermittent service is required. It is then admitted to be the best and cheapest fuel. But, when used for cooking, the unmistakeable superiority of gas is most apparent; and the progress which has been made in this direction, wherever there has been the opportunity—progress, in spite of apathy and prejudice—proves that for cooking purposes the gas-range has no equal. From the standpoint of the manufacturer of gas, this is extremely satisfactory. Gas-fires are a very useful adjunct to ordinary winter business; but cooking-stoves create a demand when the works would otherwise be comparatively idle. The encouragement of day and summer consumption tends towards a nearer approach to uniformity of demand; and this is perhaps as much to be desired by ourselves as by our electrical friends. It is to gas-cooking stoves that we must look, as the principal means for the attainment of this end; although there is room for much improvement in the development of gas for industrial and technical purposes.

In this direction will also be found the best remedy for a complaint from which small gas undertakings especially suffer —namely, excessive capital in proportion to the amount of their yearly business; and it is only by fostering summer consumption (which does not need additional capital outlay) that they can hope to neutralize the effect of this disadvantage, and to materially reduce the price of gas. This class of trade yields a profit which is so substantial as to make it almost the duty (certainly the best policy) of every manager of every gas-works, large or small, to advocate its adoption. If no trouble is spared to give the new venture a good start—say, by some such means as an attractive exhibition, with lectures on gas cookery—the

results will be at once apparent. Each efficient cooker will be its own best advertisement; and its influence will sometimes be traceable through a large circle of acquaintances. After a short interval, business may be stimulated by the publication of local testimony to the advantages of cooking by gas, which can be obtained readily enough. The letting-out of gas-stoves will be found to cause increased sale, directly and indirectly, inasmuch as the use of gas for this purpose generally has an effect in removing any prejudice which may exist against gas-fires and other gas apparatus. The business is both permanent and certain; and it does not fluctuate. Under ordinary circumstances, those who have used gas-ranges which are properly fixed will not be without them if they can help it. It is essential, however, that the cooker be "properly fixed," if it is to give satisfaction. If this is not done, it will be an unmitigated nuisance, not only to the person using it, but to everyone else in the house.

The profit which is derivable from this source can be conveniently divided into that which is made in the winter and that in summer. It is a well-established fact that, in many cases, a large amount of gas is used for cooking throughout the year. Stoves are frequently fixed because the ordinary kitchen range cannot be made to work properly; and the undoubted superiority of the results achieved in a gas-oven causes it to be used during the whole of the year by no inconsiderable section of the community. It is, however, difficult to estimate, with any approach to certainty, the amount of gas so consumed in the winter quarters, unless a special meter is affixed to the cooker —particularly now that gas-fires are becoming more common. I have, therefore, confined myself to the increased consumption during the two summer quarters only; and this the more readily, as it is to the profit on this extra summer consumption that I particularly wish to refer.

I have tabulated a large number of our customers, who are using the two sizes of cooker most in vogue in Lincoln. These are a small unjacketed cast-iron stove which costs us £1 8s.; and one which we buy for an average of £3 6s. 8d., which is enamelled and jacketed with a non-conductor. In each case, the consumption has been taken during the summer preceding the fixing of the range, and compared with that for the corresponding period after its use has commenced. The average increase due to these two stoves amounts to 7500 cubic feet for the smaller, and 9200 cubic feet for the larger. Note that this is not the annual increase, but only that caused during the two

summer quarters. As a rule, a bigger stove shows a relatively higher consumption, and costs proportionately more to fix; but these sizes will serve to indicate what may be expected from an ordinary household.

The average inclusive cost of fixing the stoves is 7s. 5d. and 9s. 8d. respectively, which covers the provision of a compo. feed-pipe, union, galvanized flue-pipe, carriage, and labour. Once fixed, further expenditure for keeping the cooker in a proper condition is very slight. The few breakages which occur, are made good at a comparatively small expense. This remark will also apply to the renewal of parts and fittings burnt or worn out.

With regard to the return which is yielded, I think we may adopt a different basis to that which would be used if the extra consumption were induced in the winter. Any increase is then chargeable (before the profit due to such increase can be estimated) with the interest on the capital necessarily expended in order that the demand may be met. But this additional summer consumption does not involve any expenditure of capital beyond the cost of the stove; and the only manufacturing items which can legitimately be said to be increased thereby are coals and purifying and labour for carbonizing. In many smaller works, there would be nothing added to this latter item. There is also an extra charge for maintainance of the cookers; but this amounts to no more than a fraction of a penny per 1000 cubic feet, and is sometimes taken into account, and returned as rental. All other expenses of manufacture would still be incurred to practically the same extent, whether the additional gas were made or not. The items I have named amount, in a case with which I am familiar, to just under 10d. per 1000 cubic feet; and the difference between this figure and what is received from the consumer is really the profit on the extra sale. Assume the selling price to be 2s. 6d. per 1000 cubic feet, then the small stove will add 18s. 9d. to the receipts during the summer; and the larger one, £1 2s. 6d.—two-thirds of which (12s. 6d. and 15s. respectively) is profit. It is in consequence of this exceptionally large return, that the business of hiring-out gas-stoves is especially useful to smaller undertakings, which are as a rule heavily handicapped by the comparatively large amount which has to be added to the cost of gas in the holder for interest on capital; and in proportion as this amount is abnormally large, so will the benefit derived from increased summer consumption be enhanced.

There is generally a further profit to be gained by means of the rental charged for the use of the cooker. In this respect,

there is considerable difference of opinion. Some hold that the rent should cover, not only the interest on the first cost of the stove, but also on the amount expended in fixing and maintaining it, as well as providing for its depreciation in value and ultimate renewal. On the other hand, there is the policy of keeping the rentals at the lowest possible figure—remaining satisfied with the profit arising out of the gas consumed. Bearing in mind how easy it is to hamper a new line of business, the latter course seems the preferable one. For the two types of cooker I have instanced, perhaps the happy medium may be found at 6d. to 1s. per quarter, which should not be much exceeded. At this figure, similar ranges can be hired in several towns, though a considerably higher rate is charged in others.

For many reasons, I believe the most satisfactory arrangement in the interests of both parties is that of hire-purchase, when computed on a moderate basis. Under this system, the consumer acquires a personal interest in his stove, which conduces to more careful usage and greater satisfaction. The gas-manager is relieved of the danger of an accumulated stock of stoves of an older pattern, which may be thrown on his hands in consequence of a fancy for something newer in design, and possibly more taking in appearance, but which does its work no better than the stove it displaces. Further, when once the period of purchase has expired, there will no longer be the liability to keep the ranges in free repair. Simple hire will, however, always be preferred by a certain class of consumers; and arrangements will be necessary to enable the majority (or that portion which is new to the use of gas as a cooking agent) to obtain the stove on simple hire for a trial period, before committing themselves to purchase.

Opinions differ as to the necessity of providing a stamped agreement for signature by the would-be hirer. This generally stipulates for a minimum of one year's tenancy, and a guarantee to make good any wilful damage to the stove. It is often difficult to say what is wilful damage, and what fair wear and tear; and as regards the other clause, the use of a gas-cooker is such a decided boon to the great majority of consumers, that the stove is retained unless a very good and sufficient reason prompts its removal. This provision of an agreement is a step which seems natural and prudent, as safe-guarding the interests of the purveyor. But, speaking from experience, the cases where it is worth its stamp are few and far between; and the necessity for signing a legal document will sometimes act as a deterring influence with an undecided would-be customer.

Where gas is supplied by a private company, of course, there is no restriction as to the extent to which the sale or hire of gas apparatus may be carried. But when the undertaking is in the hands of the local authority, a certain amount of trade jealousy will mostly have to be contended with. The demand for cooking-stoves is very limited until they are brought within the reach of all by easy terms; and sometimes arrangements can be made for the fixing to be done by local gas-fitters, under supervision. In this case, their gain will probably more than counterbalance their loss. There can, however, be no doubt that gas undertakings should always be considered as purely business concerns, and worked on business lines.

As to the average life of a gas-cooker, and the allowance which will cover depreciation. In this connection, we have not (after seven years) any stoves which can be said to be worn out; most of them being, for all practical purposes, as good as new. This appears to be a very satisfactory proof of their indestructibility, especially when the trifling initial cost of the smallest is borne in mind. I should think a considerable proportion will be in good condition after, say, fifteen years' constant service; and as by that time each cooker will have paid for itself, perhaps two or three times over, it may be consigned to the scrap-heap when worn out, without much compunction.

When fixing a gas-stove, it will not be found that, in the ordinary run of cases, any enlargement will be required either of the service or the meter. The supply for the cooker will nearly always, however, have to be taken directly from the meter outlet. Sometimes it may be possible to obtain an efficient supply for the smallest size from some internal fitting nearer than the meter; but this is seldom or never practicable with any larger stove. In the distant future, we may hope to find a pipe of sufficient capacity laid to a convenient recess for the cooker in every decent cottage; but I need hardly say that this is at present very much the exception, not only with the cottage, but with any other class of house. Too much importance cannot be attached to the maker's injunction to allow an ample supply; and economy in this particular is much to be deprecated. Unless the connection is of unusual length, the main-pipe of the range will be the best guide as to size; but care should be exercised that the bore is not crippled by careless workmanship. As soon as any considerable number of cookers are in use, it may be found advisable to allow 3-10ths or 4-10ths additional pressure during that part of the day when they are most wanted. This was necessary in our own case.

Assuming that the stove is in a perfect condition, and has an abundant supply of gas, the most probable ground of complaint will be the stench-pipe from the oven. Much trouble has sometimes to be taken before this part of the equipment can be made to work satisfactorily. The best material of which to make these pipes is galvanized sheet iron; and they should be taken into the nearest flue or chimney with as little deviation as possible. If no chimney is available, perhaps the best alternative is to carry the pipe into the false-roof. Only in the last extremity should it be led through an outside wall, and where this cannot be avoided it should be continued until it is about a foot higher than the top of the wall; but stench-pipes of this description are nearly always liable to a reversal of the current. Matters are sometimes improved by covering such a flue with non-conducting composition, or by enclosing it in a wooden casing. This prevents the cooling of the products of combustion, and their consequent return into the oven. No pains should be spared to render this part of the apparatus effective. A gas-cooker which is always liable to extinction of the oven-burners is a source of much danger; and, apart from this, nothing is more objectionable than to find the house filling with noxious fumes.

The other complaints to which attention will be necessary are mostly due to the presence of grease or dirt in the burners; and special attention should be directed to the printed instructions for keeping them clean. The usual effect is that the burners refuse to light properly; and in this respect Mr. Fletcher's caution—that no tampering should be allowed with the adjustment of the proportions of gas and air—ought to be enforced. If the cooker has once performed satisfactorily, the fault can nearly always be found, and removed, without this being interfered with.

The most expensive item connected with the maintenance of gas-cookers is that of cleaning, and, when necessary, repairing those which have been returned from hire. The condition in which some of these are received is anything but creditable to those who have used them. After all the dirt and burnt grease have been removed, a coat of Berlin black, and the provision of new tins and fittings (if required), should enable the range to be re-let nearly as readily as a new one. The cost of this course of treatment will average perhaps 5s. per stove. But much can be done in this direction when other business is not pressing; and it will then cost practically very little.

Before concluding, I should like to draw especial attention

to the importance of pushing the hiring-out of cookers among what are generally known as the working classes. Few towns have such a relatively large artisan business as Lincoln; and experience shows that, as a class, they are exceptionally worthy of cultivation. The use of cooking-ranges is certainly not encouraged amongst them to the extent it deserves. The sizes I have named (and especially the smaller one) lend themselves admirably to this business; and, if fixed free of cost, with a low rental, it should not be a difficult task to convince working-men of the many advantages to be gained by their adoption. They occupy very little room; and more particularly in small houses with such a summer as the one we have just experienced, they will make all the difference between a comfortable home and the reverse.

In this connection, prepayment meters should be of use, as affording a ready means of proving that gas can be used for cooking at least as cheaply as coal, which proof is invariably necessary. In homes of this description, the stove is under the personal supervision of the mistress; and the trouble which is experienced in other circles, with the servant girl, does not here exist.

From our point of view, this field will be found to repay cultivation to an extent equal to, if not greater than where larger stoves are required; and in most towns the field is extensive enough. As sellers of gas, we are becoming more and more alive to the fact that, with regard to its use for lighting, there is ample room for extension among houses of the smaller class; and the same may be said with equal force with reference to its application for cooking purposes.

There is no valid reason why the possession of a gas-cooker should not be with all classes the rule, and its absence the exception. Once used in this manner, gas speedily becomes practically indispensable; and it is promoted from its position as a convenience, into that of a necessity in every well-regulated household.

Discussion.

Mr. W. J. BEST (St. Ives) remarked that, if they ran a pipe from a gas stove or engine into the open air, as mentioned by the reader of the paper, he was afraid it would result in some trouble.

Mr. C. W. GRIMWOOD (Sudbury) said some of the members might think he was a little conservative; but he must say that he preferred selling gas-cookers to letting them out on hire. At Sudbury, he had now 60 gas-cookers in use, with an annual

consumption of about 12 million cubic feet; and the majority of them had been sold. He made a rule, if he did hire them out, of charging 10 per cent. on their cost. It saved a good deal of trouble if the service-pipe for the stove was taken direct from the main; and he would go farther than that. He would have the old coal stove taken out, and make a thoroughly good and neat job of it. With regard to the cookers referred to by the author as costing £1 8s., he had not seen anything at that price which he should like to buy; and in small towns where they had to charge a high price for gas, they must have cookers which would do good work. His charge for gas for cooking was 4s. per 1000 cubic feet; and he found the average consumption for this purpose came to about £1 per quarter. In his case the consumers were bound to use the cookers all the year round, because he removed the coal ranges.

Mr. HAWKINS said that he had recommended his Committee not to hire out stoves, but to sell them at cost price, and fit them free of charge. At the exhibition they held at Spalding two months ago, there were rather more than 30 stoves sold; and they were still receiving orders. He never took the supply for cooking-stoves from the existing fittings, unless they were very large; and in some instances they had fixed meters to the stoves. In one case they fixed a stove on April 19, and took the meter registration on July 19—that was 92 days—and the cost for cooking (it was a large house) averaged 3¼d. per day. Throughout that time, coal was dispensed with; and the consumer reckoned he had saved a little over 10s. by using gas instead of coal.

Mr. WIMHURST remarked that, if they could not get the consumers to buy stoves, they must let them on hire. At Sleaford they started in the stove business thirteen years ago; and a fair trade had been done ever since. At the present time, they had only one small cooker on hand. Whenever a stove was returned for cleaning, he charged the cost of doing this to the consumer; and in only one case had there been a refusal to pay. They had also lately been introducing the penny-in-the-slot meter; and in all cases they had put in a boiling-ring as well, and in some cases a small cooker—charging for this 9d. per quarter extra. Since the 1st of June, 60 of these meters had been fixed.

Mr. DRAGE stated that some seven years ago, they had an exhibition at East Dereham, and 30 stoves were let out on hire; but nine or ten of them had since been returned. Consumers seemed to let the stoves get into a very bad state; and then it

took a man two or three days to properly clean them. They charged 3s. per 1000 cubic feet for gas used for cooking, and 4s. 6d. for that consumed for lighting; and the former price he found did not pay them by a long way.

Mr. BARTON also stated that he let out gas-cookers at Peterborough; but he was not at all sanguine about them being called a success. He should prefer selling the stoves on the deferred payment system to letting them out on hire.

Mr. MANWARING, in reply, said with regard to Mr. Best's remark as to the stench-pipe being carried into the open air, he had said that it was the worst plan that could be adopted; but there were some cases in which it could not be avoided. There was no doubt that selling the stoves outright was to be preferred; but he thought the hire-purchase system was the best way of getting rid of the cookers. But at Lincoln the ironmongers had stepped in; and local influence had made it rather a difficult matter to get the Gas Committee to see the matter in that light. Running a service-pipe direct from the main for cooking-stoves would result in too many holes being made in the main; but it was quite as good, and saved expense, to carry a separate service from the meter. As to Mr. Grimwood's remark that the small stove was not worth his attention, in their case it paid better than any other; and the working men preferred it nine times out of ten. Since writing his paper, he had come across some figures published by Mr. Chester, of Nottingham, in which he placed the average life of a gas-cooker at eighteen years.

The CHAIRMAN said he was surprised that there was not more cooking done by gas in this country. He had been told that cooking in this way was not healthy; but he was a living monument of a man who had lived for over 40 years on food cooked by gas (laughter). For a cooker to be a success, it was desirable to have an ample service; and he rather inclined to the idea of a separate supply, because it was then possible to ascertain most accurately what was the cost as compared with cooking by ordinary coal fires. There was one thing which gas-stove makers should turn their attention to, and that was the production of a burner that would not fire back. The gas was imperfectly consumed; and the poisonous chemical compound acetylene was formed, which, when diluted with air, had a most objectionable smell. He also expressed himself as strongly opposed to the hiring-out of stoves.

A hearty vote of thanks was passed to Mr. Manwaring for his paper.

Election of Officers.

On the proposition of Mr. Barton, seconded by Mr. Weller, Mr. W. J. Carpenter was elected President for the ensuing year; and, on the motion of Mr. Greaves, seconded by Mr. Hawkins, Mr. Grimwood was selected for the vice-presidency. Mr. Wimhurst was re-appointed Secretary and Treasurer; Mr. W. J. Wells (Stamford) and Mr. Hawkins were elected members of the Committee; and Messrs. Weller and Ellis were appointed Auditors.

Place of Next Meeting.

The Chairman proposed, Mr. J. H. Troughton (Newmarket) seconded, and it was agreed, that the spring meeting in 1894 should be held at Bury St. Edmunds.

Alteration of Rule.

After a brief discussion, it was agreed that Rule 10 should be altered to read: "That the meetings of the Association shall be held on the third Wednesday of April and September," &c.—it being generally admitted that March was too early for the spring gathering.

The Federation Question.

The Hon. Secretary read a letter which he had received from the Secretary of the South-West Association (Mr. Norton H. Humphrys) in regard to the subject of the federation of Gas Managers' Associations, and enclosing the two resolutions passed at the meeting of that Association in April.* The Committee (Mr. Wimhurst added) had decided to leave the matter in the hands of the members.

The Chairman remarked that, in his opinion, one of the chief points in connection with local institutions was that they were distinct and separate one from another; and, in consequence they were more useful.

Mr. Carter inquired if the Committee had not more information on the subject than was disclosed in the resolutions. The question would, he said, present itself to the minds of every one of the members, What useful purpose would be served by federation?

The Chairman thought that the advantages would be problematical; and, with the information before him, he should not be prepared to support the proposal.

The Hon. Secretary remarked that he understood the Midland and the North of Ireland Associations had each appointed

† See *ante*, p. 70.

two representatives to attend a conference on the subject to be held in London on the 23rd of September.

Mr. BARRATT also said he should like to have more information as to the benefits that would result from federation before they entered upon it. He thought the Committee ought to have inquired further into the matter, so as to have had something definite to place before the members.

Mr. HAWKINS was of opinion that two members ought to be appointed to attend the conference; and he proposed that Messrs. Carpenter and Grimwood be their representatives.

The motion having been seconded, it was put to the meeting, and six votes were recorded in its favour and eight against—several members abstaining from declaring either way.

[It was subsequently found impracticable to arrange for this meeting to be held.]

VOTES OF THANKS.

Resolutions were next passed, thanking the President and officers for their services during the past year, and acknowledging the kindness of the Trustees of the Collis Memorial Hall for allowing the Association to meet in it, and also that of the Gas Company for their entertainment earlier in the day.

In the evening the members and a number of friends dined at the George Hotel, and subsequently the usual toasts were duly honoured.

NORTH OF ENGLAND ASSOCIATION

HALF-YEARLY MEETING, OCT. 7.

This Meeting was held at Middlesbrough, under the presidency of Mr. DAVID TERRACE, the Engineer and Manager of the Corporation Gas-Works.

The members assembled at the Town Hall, over which they were shown by an official; and subsequently they repaired to the Council Chamber, the use of which had been granted to the Association by the Corporation.

WELCOME BY THE CORPORATION.

The MAYOR (Mr. C. Lowthian Bell) took the chair, and expressed his pleasure in giving the Association a very hearty welcome. He personally felt greatly honoured that they had with them the President of The Gas Institute. They were all, at that moment, regretting the loss which they, as engineers, had sustained this year in the death of a gentleman who, he believed, was a promoter and first President of the Institute; he referred to the late Mr. Hawksley. The Association was an offshoot of the Institute; and he believed that, of all such offshoots, the North of England Association had done more to promote and improve gas manufacture than any other. He took it that a gas manager had to be, first of all, an engineer; and, secondly, if not equally, a chemist. He thought they had proved this by electing as their Vice-President—and probably as their President next year—a gentleman who was one of the most celebrated men in Middlesbrough, and whose name as a chemist was known probably all over the world—that was, his friend Colonel Sadler.

Alderman HUGH BELL said that, on behalf of the Gas Committee, it was his very pleasant duty to reiterate the welcome which had been offered to them by the Mayor on behalf of the town. It was a great satisfaction to the Committee to see so important an assembly of gas engineers gathered to assist them, by their discussions and by their presence, in the work they had undertaken. It was said, but on this occasion he was fain to believe that the proverb was untrue, that "the

shoemaker's wife goes nearest the ground;" because, if it were true, one would have expected that the North of England gas managers, being so near an important coal-field, would have been very backward in the matter of gas making. He was glad to know that this was not the case; and that, being near the coal, they had not thought this their privilege, and regarded it as part of their share of good luck, and so been led to neglect the scientific part of their business. He welcomed them the more heartily because they were about to inspect the plant the Corporation had recently erected at the gas-works under the advice and with the assistance of their Engineer. He read with much interest the account of the last meeting of The Gas Institute in Belfast, when a paper by Mr. Terrace on the subject of inclined gas-retorts was made the occasion of much discussion; and Mr. West would perhaps allow him to say that, of all the speeches on the subject, none were of more vivid interest than the remarks which fell from him. Now, when they had new plant erected, they did not wish to hear the good opinions about it; they wanted to hear the bad ones. Might he venture to express the hope that Mr. West's opinion had ripened, and that he had seen some reason to alter it? It would be, at all events, a very great satisfaction to them, whether he held the same opinion still, or whether he had modified it, if he would give them his views when he had visited the plant. He (Alderman Bell) trusted he was not trenching on delicate ground, nor revealing commercial secrets, when he said that Mr. West was not altogether without interest in the erection of inclined retorts at another place; and, as he would not have undertaken—at all events without serious protest—to provide machinery of the character suggested, he ventured to hope that, since the last meeting of the Institute, he had seen his way to reverse his opinion as to inclined retorts. The fact was that out of discussions at meetings such as theirs arose all the improvements which it was possible to make in industrial undertakings; and, for this reason, interested as they were in Middlesbrough in a very important branch of the Corporation undertakings—a portion which yielded them a not inconsiderable revenue—they could not fail to see with pleasure the presence of so distinguished a company as they had with them that day. His brother (the Mayor) had referred to two aspects of the gas manager; he ventured to refer to a third. The engineering and the chemical capacities of a gas manager were beyond all question. There was no doubt that, in both of these, he required to be well instructed. But another aspect

in which he might be looked at was the relations that must necessarily subsist between him and those in his employment. In the past few years, they had all seen a great change in the conditions under which labour at gas-works was carried on. At the present time, there was no more pressing matter than the finding of the conditions under which the labour employed in the manufacture of an article should be applied in the way which was most advantageous both to the producer and the labourer. It was because it appeared to him that the inclined retort presented one of the solutions of this very difficult problem that he—with great diffidence, so far as his own judgment went—was not unwilling to see the erection of such a plant as they were going to visit. Those who were in the position of having to supply apparatus must approach the subject from a very different point of view; but those engaged in the supply of gas must, he thought, look at it in the way he had indicated.

The PRESIDENT observed that he took it as a personalfavour, and he was quite sure the Association felt it a very high honour indeed, that the Mayor had attended their meeting to welcome them; and, in the name of the Association, he thanked him.

Mr. J. WEST (Manchester) expressed his great pleasure at having the opportunity of being present. He said his Worship had referred to a very old and esteemed friend of theirs—one of the promoters, if not the promoter, of the Institute which he represented that day. Mr. Hawksley was the President for three years; and, during that period, the Institute made great progress, although it took a very long time before it gained a considerable following. They were now a very large body indeed, representing most of the towns in England. As to Mr. Hawksley, he could only say that all who were acquainted with him knew him to be a man of intelligence and ability; and at Nottingham, Derby, and other of the large towns, they would see works which would long remain a monument to him. He (Mr. West) was pleased, as father of the parent Institute, to come to the North to welcome its loyal sons. Of course, they were all present there as free lances, and to give free expression to their opinions. He had never hesitated to do so. He was prepared to repeat what he said at Belfast. He said it conscientiously; and he could only say that he was, on that occasion, much pleased that Mr. Terrace brought forward something very tangible. It was the first time that they had before them anything like figures showing the application in detail of the process; and he believed that the figures then presented, and the economy shown, would be still further

reduced. They need hardly take it that, because he was putting up machinery for inclined retorts, he accepted everything that was being done in that line.

NEW MEMBERS.

The PRESIDENT having taken the chair,

The HON. SECRETARY (Mr. W. Hardie, of Newcastle) submitted the names of the following gentlemen, who were unanimously admitted to the Association: Member: Mr. G. W. Young, of Harrington. Associates: Mr. W. Phillips, of Sunderland; Mr. J. S. Walton, of Corbridge; Mr. W. T. Grahamsley, of Morpeth; Mr. G. T. Duncan, of Birmingham; Mr. M. W. Helps, of Leeds; and Mr. John Mackay, of Edinburgh.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

In presenting to you to-day a few passing thoughts on current methods of work in our industry, that may prove of interest and perhaps value, allow me first to thank you for the honour conferred in electing me to preside over your deliberations during the year. I intend, however, only to touch upon such subjects as are most prominent, or engaging our attention in a most marked degree at this time.

Competition and rivalry are hard at work; and this is exemplified not only in having to meet our "pale brother," electricity, in the field, but also in being confronted with so many different methods of work in our every-day labours, that it is often very difficult to choose the best in the interest of company and consumer. This can only be done after thorough and exhaustive investigation. Even then different conclusions are arrived at by different investigators—perhaps owing to the different conditions and circumstances under which they are working. It is one thing to prove, or have the courage to adopt, a principle, but quite another to work it out to its natural conclusion. The latter element is in a sense more important than the former; for the development of many a good invention has been ruined in its application, or by carelessness in working.

The more recent forms of carbonizing processes are all more or less familiar to you. To-day, inspection is being made of the inclined retort system which has been adopted here, and on which a paper was read by the writer at the Belfast meeting of The Gas Institute in June this year.* It is a mode of relieving arduous hand-labour by what may be termed "stationary

* See *Journal of Gas Lighting*, Vol. LXII., p. 18.

machinery" and the law of gravitation. This principle is easily adapted to moderate-sized works as well as to large works; whereas charging and stoking machinery "on wheels" may be more applicable to the larger works, where it can be kept constantly employed on a sufficient number of retorts to make it profitable.

Another method of carbonization is claiming attention at present, in the Yeadon revolving retort, a paper on which was read by me at our April meeting in Newcastle-upon-Tyne. After pointing out the several advantages accruing from this system, the results of the experimental work were given, and were fully discussed. We are now waiting the practical outcome of actual work in some towns where it has been decided to adopt this form of retort.

A new departure in the production of illuminating gas from liquid hydrocarbons has lately been introduced in what is known as the Peebles process (Young and Bell). Hitherto the method of manufacturing gas from liquid hydrocarbons has consisted in running or injecting into the retort or oil-decomposing arrangement, the liquid hydrocarbons at such a rate in relation to the temperature of the retort or decomposing vessel that it was, as far as possible, converted into gas at one operation. Considerable difficulty has been experienced in the adjustment of these conditions. If the rate of injection of the hydrocarbon was too fast, oil escaped decomposition—entailing waste; and, on the other hand, when the flow of oil was too slow, the hydrocarbon was over-decomposed, and there was formed soot and pitchy matter, which clogged up the apparatus. So great, indeed, was the difficulty experienced, especially with tars and oils containing a large quantity of carbon, that they have not been hitherto available for the production of gas upon a commercial scale. By the Peebles process—by which the difficulties are completely overcome—the oils or tars to be gasified are purposely allowed to flow, or are injected, into the retort at such a rate that only a fractional part is decomposed each time it enters the retort. The large quantity of oil or tar leaving the retort ungasified during the process of condensation, serves as the agent to wash out of the gas the condensable vapour, and to hold in suspension any sooty matter; and it is, along with the fresh oil or tar, made to flow back against the current of gas, and is run or injected a second time into the retort. The process of alternate fractional decomposition and condensation then goes on till the whole of the hydrocarbon is split up into gas and coke.

This method would appear to be suited to the gasification of all descriptions of liquid hydrocarbons—from the purest petroleum to the crudest tar. The higher grade of oils would produce gas of very high illuminating power, suitable for enriching coal gas; while the cruder tar from our coal-gas making yields a gas having an illuminating power considerably higher than the gas produced from the coal from which the tar was obtained.

The process is also exceedingly simple, and is likely to prove of considerable value, in giving us in future the power to check the ransom prices of cannel coal and enable us to keep up the value of tar. It has always appeared to me to be bad policy to import cannel, and so pay equivalent to 2d. to 4d. per candle for (say) the seventeenth candle; while we sell the other sixteen at the rate of 1½d., when using the coal from the nearest sources. When, however, the enrichment can be done by means of oil or tar—as is accomplished by this process—at, or even considerably under, *pro ratâ* cost, the circumstances are different. It might then be desirable, for various reasons, to supply a higher quality of gas. Situated, however, as a large number of gas managers are, requiring to supply gas only of such a quality as can be easily produced from local coals, their interest in the process will centre in its application to the production of gas from tar, and especially at the present time when tar and tar products are at such a low price.

That being my own position, I have obtained analyses of results bearing upon the subject. From a ton of tar derived from South Durham coal was produced by the new process (when gasified) 13,965 cubic feet of gas, of 24·1-candle illuminating power, and 15 cwt. 1 qr. 2 lbs. of coke. From a ton of tar from Yorkshire coal, from a gas-works using a percentage of Nottingham cannel as an enricher, there were produced 14,414 cubic feet of gas, having an illuminating power of 25·1 candles, and 15 cwt. 2 qrs. 4 lbs. of coke. The coke from both tars was of fine quality, containing very little sulphur and less than 1 per cent. of ash—principally oxide of iron

The value of tar as a gas producing material will, of course, vary—dependent on a variety of circumstances, such as location of works, influencing cost of coal and sale of coke and tar; and in the case of works distilling their own tar, only those parts of the distillation having a low commercial value would be worked up into gas. Creosote oil yields about 16,880 cubic feet of gas of 28-candle illuminating power, and 10 cwt. 3 qrs. 9 lbs. of coke. Applying these figures to your individual circumstances,

you will be able to calculate out for yourselves the value of your tars as gas-producing materials. I may mention that Russian residuum yields, per ton, 21,385 cubic feet of 70-candle gas, and 660 lbs. of coke.

At the summer meeting of the Institution of Mechanical Engineers, held here, a paper was read by Mr. Jeremiah Head, on "Cleveland Industries," in which reference was made to the great benefits obtained by the use of the Le Chatelier pyrometer in controlling smelting operations. The apparatus, which can be made self-recording, may be connected by conductors to the manager's office. Such an instrument applied to our retort-ettings, would be of great value; as it is equally imperative that our carbonizing operations should be conducted with all the regularity that pertains to that of blast furnaces and similar work. A description of the apparatus, as given by Mr. Head, will be interesting to you. He says: "The perfect control of smelting operations has hitherto been rendered impossible or difficult, for want of an instrument capable of indicating high temperatures with accuracy. Such an instrument can now be obtained in the Le Chatelier pyrometer, on which a paper was read before the Cleveland Institution of Engineers in November last, by the Mayor, Mr. Charles Lowthian Bell. A thermo-electric couple of platinum and platino-rhodium wires is inserted permanently in the blast main, or any of the gas down-comers; and it is connected by conductors with a galvanometer placed in the manager's office. The galvanometer, by means of a twisting mirror, causes a beam of light to fall upon a scale, from which the temperature is read off. On the improved plan devised by Professor Roberts-Austen, the beam of light, instead of falling only upon the scale, is caused to act on sensitized paper, coiled on a clock-driven barrel. On this, it traces a continuous curve, recording autographically every change of temperature. A complete check is thus provided day and night upon the operations of the furnace-men; and a clue may be obtained to the causes of troubles, and their remedy be facilitated, in a way which otherwise would not be possible."

The principles which govern the condensation and scrubbing of gas are fairly understood, and no doubt acted on to a greater or less degree. But I think that, though much has been said and written on purification proper, there is not such a decided opinion as to the best methods of working. We are all agreed that the efficient and economical way in which this is carried out is a matter of great importance, not only in regard to the purity of the gas, but also as to the cost in wages as well as material.

There can be no doubt that the gas may be most economically and efficiently purified when a small percentage of air is used as an aid to purification, and that without diminution of illuminating power. The air may be either forced in at the purifiers or drawn in at the exhausters—the latter being the preferable mode. With such an arrangement, double the quantity of gas has been purified per change, and the sulphur compounds (which previous to introducing air could not be got below 35 to 40 grains) reduced to 14 to 18 grains per 100 cubic feet of gas. The cost in wages for purification is also considerably reduced—indeed the total cost for purifying, including wages and material, being a little under ½d. per 1000 cubic feet of gas. This clearly shows that by using a small percentage of air—say, from 1½ to 2 per cent.—gas can be not only very economically purified, but sent out to the consumers almost entirely free from sulphur compounds. I think this also shows that expensive and complicated plant for the manufacture of oxygen, to aid in gas purification, need not be incurred, when the small cost of a meter fixed to the outlet of the condensers is all that is necessary to regulate the quantity of air drawn in.

You are doubtless all familiar with the efforts which have been made by Mr. William Cowan, of Edinburgh, in the direction of automatically regulating pressure in distribution. His latest system is to apply an auxiliary small gasholder (or regulating vessel) connected to a main at a remote point from the works' governor. The auxiliary holder in its rise and fall, according to the pressure in the district, operates water-valves for loading and unloading the governor. This is accomplished in such a way that a certain equal pressure is constantly maintained automatically. The invention also includes provision for the automatic alteration of the normally constant pressure, in the event of such alteration being found necessary.*

The use of "penny-in-the-slot" (or prepayment) meters is now past the experimental stage, as large numbers of them are being fixed in some of the principal, as well as in the smaller towns. They are simply a means of selling gas retail instead of in bulk, with the usual consequence of the consumer having to pay an enhanced rate for the accommodation. It appears, however, that this is cheerfully done; so we need not on that account adhere entirely to meters in their usual form. The use of these new meters is promoted in order to increase the sales of gas; and one great advantage should accrue in respect

* For an illustrated description of Mr. Cowan's appliances, see *Journal of Gas Lighting* Vol. LXI., pp. 19, 886; and Vol. LXII., p. 82.

to the better development of the gas into light, which is still a matter of chance on the part of the consumer. Gas companies in supplying fittings should see that not only has a certain number of feet of gas been given for the penny, but opportunity should be taken of fixing proper burners, adapted to the pressure and light required, which circumstances are entirely overlooked by the average gas-fitter, to the detriment of the average consumer. For notwithstanding all that has been done by way of instruction by gas companies in this respect, ignorance and waste prevail. Consumers are still heedless of the fact that any slight variation in the quality of gas is as nothing compared to the wasteful means they use in consumption—any difference in quality not ranging more than 5 per cent., while badly applied burners are destructive of light to the extent of at least 30 per cent. An additional 30 per cent. loss is also entailed by the use of globes of the old type.

After the very able exposition of "Gas *v.* Electricity" by the President of The Gas Institute (Mr. Denny Lane) this year, at Belfast, I fear there is little ground for me to touch on the subject. I should like to reiterate, however, in as clear a manner as possible, the relationship in the cost of the rival lights to the consumer—*i.e.*, light for light. This has hitherto been stated more or less clearly, and sometimes with a certain vagueness on account of the technicality of the subject. Perhaps the following table will emphasize the information in as lucid a manner as it can be stated :—

Comparative Cost of Gas and Electric Light.

Electric Lighting at 6d. per Board of Trade Unit.			Gas (16-Candle) at 2s. per 1000 Cubic Feet.				
			Ordinary Open Flames given by Burners.		Standard Argand Burner.	Regenerative Lamp.	Incandescent Gas Light.
			As commonly used.	Adapted to Pressure of Gas and Light required.			
Number of Units said to be Equivalent to 1000 Cubic Feet of 16-Candle Gas.		Cost.	Candle Power per Cubic Foot of Gas Consumed.				
			1½ to 2	2½	3½	10	20
Allowed by Board of Trade	10	5/-	3/10	2/4	2/-	-/8	-/4
Practical men estimate	12½	6/3					
One-sided advocates say	6	3/-					

It is thus that electricians compute (the 3s. 10d. against the 3s.) the cost of their light being "cheaper than gas." Their assumption of 6 units instead of 10 units, allowed by the Board of Trade as being equal to 1000 cubic feet of gas, is a wilful playing with "standards of light." It is, however, done with the greatest *sang froid*. Were the gas industry to be as guilty of misrepresentation, it could with all reason adduce the latest development in economical lighting by gas—viz., the incandescent light, which reduces the cost to one-sixth of our standard, or one-fifteenth of the cost of electric light. The fair way to put it, however, is: Gas standard, 2s.; electric light standard, 5s.—*i.e.*, electric light two-and-a-half times the cost of gas, light for light.

There are about 600 towns which may be expected to use the electric light, if it were a success commercially; but only 5 per cent. of these as yet have each a comparatively small installation. The average proportion of light in such towns is 2 per cent. electric light and 98 per cent. gas light. Taking the proportion of electric lighting for the whole country, we find it to be 1 per cent., against 99 per cent. of gas light in use. This year 18 towns have applied to the Board of Trade for powers, against 24 the year before—out of the 300 to 400 which "intended" to apply. As the number of towns experimenting with the new light is in a decreasing ratio, this shows that it has reached its level, and that it now appears in its proper guise in the estimation of those who may adopt it, if not in that of the electrician and capitalist.

I would commend those towns about to adopt an electric light installation to note what was published a few weeks ago from the home of electric lighting—America—where it has got such a foothold; gas being three to four times the price paid in this country. It is said that "33 out of 56 electric lighting companies doing business in Massachusetts did not pay any dividend last year, while the average dividend paid for the year by the whole 56 companies [as many as are working in this country] was only 0·0235 per cent."

In these few sentences, I have endeavoured to place before you the status of the gas industry in regard to its manufacturing and distributing plant, as well as to our rival in the field—electricity. The adoption of prepayment meters, meets the case of a greater competitor—oil—for domestic lighting. It also would soon fail, so far as economy goes, were gas consumers alive to the fact that they could light their houses, even with ordinary open-flame burners, at least 30 per cent. cheaper

than they do at present, by simply using burners properly adapted to their requirements. It is well known that gas of (say) double the quality we supply is often deteriorated to less than half its value by consuming it under high pressure and in small burners; whereas both it and poorer quality gas can be readily made to give greatly increased lighting power, according to the means taken to secure this.

The future of electric lighting may be briefly summed up in the words of that great scientist, the late Sir C. W. Siemens, who said, when he was President of the British Association, in 1882-83: "Improved gas lighting may continue its rivalry with electric lighting, both as regards economy and brilliancy, and such rivalry must result in great public advantage."

On the motion of Mr. J. HEPWORTH (Carlisle), seconded by Mr. T. TREWHITT, J.P. (West Hartlepool), a vote of thanks was accorded to the President for his address.

MR. G. R. HISLOP'S PATENT RETORT-SETTINGS.

The discussion on the paper by Mr. Er W. Smith on the above subject, read at the previous meeting (see *ante*, p. 115), was then taken.

The PRESIDENT, at the outset, suggested that perhaps it would be better if Mr. Smith epitomized his paper, and so opened the way for the discussion.

Mr. SMITH said, in giving a *résumé* of his paper, perhaps he should commence with the most distinguishing feature of the settings under consideration—viz., the comparatively shallow producer and sunk chamber. In the settings of sixes which they had at Cockermouth, the total depth of the sunk chamber was only 4 ft. 10½ in.; and this depth rendered practicable their adoption in places where any deeper furnace, perhaps, would not be suitable—such as where water was likely to be met with in the foundations. The producer was 2 ft. 8 in. wide by 4 ft. 7¼ in. high. The ash-pans were arranged one on each side of the producer; and there were no fire-bars. The secondary air supply was admitted through suitable openings left on either side of the furnace; and the primary air through discs at the ash-pan doors, which enabled the quantity needed to be very easily regulated. The waste gases, after the products of combustion had done their work in heating the retorts, were conveyed down each side of the oven and sunk chamber to a flue under the ash-pans, and made to do extra duty in the evaporation of the water required for the furnace. There had been no difficulty so far with these settings in obtaining

sufficient steam from the pans to keep the clinker friable. In their general working, he might say they had been able to burn off the charges in four hours. The clinkering of the furnaces was very easily carried out; being a matter of only a few minutes' labour, and this only at periods of 48 hours. The production of gas per mouthpiece had been about 7000 cubic feet per 24 hours. This result was very good, when it was remembered that the quality of coal used was very much inferior to that of Northumberland and Durham. The yield of gas per ton of coal before these settings were introduced was very much below what it was now. The fuel account had reached the low figure of 11 lbs. per 100 lbs. of coal carbonized. He was able to add some little information to that which was given in his paper as to the cost of the settings; one or two more recent cases in which these furnaces had been adopted having now come under his notice. In one instance where a bench of 64 retorts was in course of erection, the total cost, inclusive of everything except excavation, worked out at about £33 per mouthpiece. This was very much lower than the figures quoted in his paper, which were supplied to him by Mr. Hislop, and would doubtless refer more particularly to prices in his district. In another case where everything had to be found for the erection of 18 retorts on the Hislop system, except nine new Tangye mouthpieces, nine ascension-pipes, and the hydraulic main, the total cost was only £527 11s. 9d., which worked out to about £29 10s. per mouthpiece. These figures included the taking down of the old bench, carrying a flue across the retort-house, cutting new openings in the hydraulic, and all other incidental charges incurred in introducing the new work.

Mr. J. HEPWORTH (Carlisle) remarked that he heard the paper read at the previous meeting; and it struck him as being an excellent contribution to their proceedings. He thought it was the first upon regenerative furnaces which had been submitted to the Association; and, as it came to them from a works of no great size, it appeared to him to be the more interesting. The advantages of the regenerative setting in large works had long been admitted, and oftentimes illustrated; but, in the case of small works, it had been somewhat more difficult to see an advantage, such as Mr. Smith had derived by its introduction. He thought, however, the paper clearly showed that the advantages had been very considerable; and now there could be no two opinions as to the benefit to be obtained by adopting regenerative furnaces in some form. It had practically come to a question of pounds, shillings, and pence; and if, by this or another method,

they could secure results at a lower figure than they were at present accustomed to, then the wisdom of adopting regenerative settings was evident. Mr. Smith in his paper said that the coke used as fuel had been brought down to 11 lbs. per 100 lbs. of coal carbonized; and they would all agree that this was a very excellent result. He was talking to a gentleman not very long ago, who startled him by stating that his fuel account had now reached the very low figure of 9 lbs. He himself had had some experience with regenerative settings; but he was bound to say he never reached 9 lbs. If, however, they could reduce the consumption of fuel from 25 lbs. to anything like 16, 14, 11, or 9 lbs., then they would do a great deal in promoting the prosperity of their undertakings. He had been looking, for some time past, for a less expensive system of regenerative furnaces. He thought it was possible to hit upon a cheaper method than had been introduced to them by Mr. Smith; but it was entirely a matter for the consideration of engineers, taking all local circumstances into account. The figures which had just been quoted by Mr. Smith very largely modified the question as to cost, in comparison with those given in the paper itself; and the fact that Mr. Smith could tell them of settings on Mr. Hislop's method being introduced at a cost of something like £29 10s. per mouthpiece, showed that a very substantial advance had been made. If they could bring the figures somewhat lower, and adopt a furnace which would reduce the cost to about £10 per mouthpiece, they would then have reached the goal.

Mr. J. WHYTE (Seaham Harbour) said he was very pleased that Mr. Smith had brought this subject before the members, because he did not know of another works in the North of England where such a system was in operation. He knew of other places where it was at work; but they were using a different class of coal. He was aware that some of the members were halting between two opinions, and did not know which method to adopt. For his own part, he some time ago introduced some of Frith's settings. At first, he was very much disappointed with them; and if it had not been for the very great expense, he would have gone in for Mr. Hislop's settings, even after he had adopted Frith's. He could not speak to his fuel account being so low as Mr. Smith's; but he charged on the six-hour system, and the yield was 6000 cubic feet per mouthpiece per 24 hours, which he thought was fair. But there was one thing that had to be said in favour of the settings he had adopted, and that was that they were not very expensive. The

great difficulty he had seen all along with Mr. Hislop's settings was the expense in their erection.

Mr. W. AIRTH (Morpeth) observed that he commenced the use of Mr. Hislop's furnaces a month previously; and he might say, with Mr. Whyte, that he expected better results. It had been a failure on his, or someone else's, part. He could only get the light tars into the hydraulic main; and they had a good many stoppages in the ascension and bridge pipes. He found that the tar collected like soot. He could take it away with his hand, like a ball; and, in fact, it hardly left any tarry matter on his hand. Their President had been to see the settings, and had given him two or three wrinkles. He had also had a visit from Mr. Hislop, who advised him to put in steam. Up till then he had flushed with water; but he had now adopted the suggestion. One of his Directors and his son were sent to inspect several systems; and they came to the conclusion that Mr. Hislop's was the best. For his own part, he was not sorry he had adopted it; still he would like to see it working better. He could get any amount of heat, and that was what he wanted, because he was anxious to have four-hour charges. On making inquiries, he found that there were others who were bothered in the same way as himself. However, he thought Mr. Hislop's system was about the best that could be adopted for small works; and he had no hesitation in saying that in a short time he would get it to work to perfection.

Mr. G. AIRTH (Morpeth) pointed out that sometimes stokers had a prejudice to a new system. At the Morpeth works, they formerly had round retorts; and he found, when they began to use the Ω-shaped retorts, the stokers thought they would have to put more coal into them. He had now started a bench on five-hour and heavier charges than were given in Mr. Hislop's instructions; and he found that the tar which remained was very little. He thought the tar became cold in the main; but, with the introduction of steam into one end, this was improved. He thought Mr. Hislop's settings better than any on the old style.

The PRESIDENT remarked that the more complicated a system was, the more care it necessarily needed; but, when some points of detail were overcome, they felt they had done right in adopting it. There were, however, certain things that they must see to, and counteract, and correct, before they had what they desired. He was very pleased that members had spoken so freely in the discussion, and had stated their difficulties, because it was only by doing so that they could ever arrive at any satisfactory conclusion.

Mr. SMITH, in reply, said he was glad the paper had raised this discussion; and he was particularly pleased that his friend Mr. Airth had taken part in it. With reference to the heavy expenditure which the adoption of the system would require, and its bearing on small works, he could only say that very often, in the selection of new work, first cost was considered more than efficiency. He believed Mr. Hislop's setting was the most satisfactory he had seen in operation. Probably the quantity of ironwork needed to make it so efficient brought up the cost considerably above a setting in which very little ironwork was required for the producer. With reference to Mr. Whyte's remarks, that gentleman had alluded to six-hour charges, and a production of 6000 cubic feet of gas per mouthpiece; but he did not give the fuel account. It seemed to him that six-hour charges were not a very great advance on the ordinary open furnace. With regard to Mr. Airth and his troubles, he was sorry he had suffered so much from stopped ascension-pipes; but he could assure him that he was very much troubled himself in that direction during the first three months or so, and he hoped that the few hints he might be able to give Mr. Airth would enable him to overcome the difficulty. He thought that Mr. Airth's son had struck the right nail when he spoke of the introduction of steam into the hydraulic main to keep the tar hot. He had known instances where the tar cooled down, which prevented it getting away, so that the dip of the seal was raised, and trouble followed with the ascension-pipes. In such cases, he lowered the seal by first forcing away the stiff tar by the aid of steam. For a while he had found it necessary to do this at regular intervals, particularly in very cold weather. He removed the cap of the dip-pipe nearest the tar outlet, and allowed a jet of steam to play into it for about ten minutes. Taking all the dip-pipes in order, they found, by the time they reached the portion of the hydraulic main immediately over the retorts in action, that they had cleared away most of the obstruction, and their troubles with stoppages ceased. By this means, he lowered the dip; and, until it began to rise again, they were free from stopped pipes. But, as soon as the tar began to thicken, and the dip to rise, the stoppages re-commenced. He thought with the President, that, in working most new inventions, very often little troubles and difficulties occurred which might be overcome with perseverance. Such an experience as Mr. Airth was going through was exactly what many others had undergone, and it was incidental to high heats; but, by taking

due precaution, his difficulties might be greatly lessened, and perhaps ultimately overcome.

A hearty vote of thanks was accorded to Mr. Smith for his paper.

Gas Undertakings in Relation to the Use of Gas-Engines.

On the *agenda*, it was intimated that Mr. H. Lees (Hexham) would read a paper on this subject; but the time at disposal was too short to allow of it being considered by the members. It was, therefore, judged advisable to hold the paper over from publication until after the next meeting of the Association, when it is to be read, and at once discussed.

The President having thanked the Mayor for his kindness in allowing the members the use of the Council Chamber for their meeting, the business proceedings terminated.

Visit to the Gas-Works.

The members then walked to the gas-works, which they inspected; paying particular attention to the benches of retorts which had been erected on the inclined system. In the office, samples of coke from coal, Russian oil, and tar were exhibited, and attracted some notice.

Shortly after two o'clock, the company were conveyed down the river, on one of the steam vessels belonging to the Tees Conservancy Commissioners, to the Fifth Buoy, where, in a building erected upon a staging in the middle of the estuary, they had dinner.

MIDLAND ASSOCIATION.

QUARTERLY MEETING, OCT. 26.

This Meeting was held at the Grand Hotel, Birmingham—Mr. B. W. SMITH, of Smethwick (the President) in the chair. The attendance was good; and, although there was no paper down for discussion, the programme of arrangements was full of interest.

The early part of the day was devoted to the transaction of the purely formal business of the meeting. This consisted of the election of two new members—Mr. P. H. Fletcher, of Evesham, and Mr. W. H. T. Norfolk, of Leek,—and the officers for the ensuing year. In a few well-chosen words, Mr. Smith proposed the election of Mr. R. O. Paterson, of Cheltenham, to the position of President—referring to the two previous occasions on which Mr. Paterson had held that office, with great advantage to the Association. Mr. Peter Simpson, of Rugby, seconded the nomination; and it was agreed to by acclamation, and suitably acknowledged by Mr. Paterson. Mr. George Winstanley, of Coventry, was elected Vice-President. Mr. Simpson was re-elected Treasurer, and Mr. Meiklejohn re-appointed to the office of Secretary; both being heartily thanked for the energetic way in which their duties had been performed during last year. Mr. C. Dakin, of Cradley Heath, and Mr. E. L. Adlington, of Worcester, were elected on the Committee, in place of the members retiring; and Messrs. Brookes and Young were appointed Auditors. Votes of thanks to the President and other officers for their services during the past year were then adopted; and the business of the meeting closed.

After luncheon, the members proceeded in brakes to the Midland Railway goods yard, where, under the guidance of Mr. J. Brookes, they inspected the Pintsch oil-gas works, where the gas for lighting the railway carriages was prepared and compressed, and also the machinery for the extensive electric arc lighting of the railway yard. Thence the visitors drove to the Windsor Street gas-works of the Birmingham Corporation. There they were received by Mr. Charles Hunt, and conducted

over that ever-growing establishment. An object of interest was Mr. Hunt's improved washer-scrubber; and the several current varieties of carbonizing plant were also in action side by side. Foulis and Arrol's hydraulic retort charging and drawing machinery was in full work; as also were the settings of inclined retorts. Although the hydraulic plant had only been at work a very short time, it was answering the expectations formed respecting it. Mr. Hunt was also putting in extensive coke conveying, elevating, and screening plant for his huge retort-houses, with the view of effecting an important saving of labour and an improvement of the commodity for the local market.

In the evening, many of the members took tea together.

SOUTHERN ASSOCIATION.

QUARTERLY MEETING, NOV. 23.

This Meeting was held at the Holborn Restaurant—Mr. C. C. CARPENTER, Engineer of the Vauxhall works of the South Metropolitan Gas Company (the President), in the chair. There was a large attendance of members; and many gentlemen specially interested in the subject of the paper to be brought before the meeting were also present.

ELECTION OF OFFICE-BEARERS.

Mr. W. A. VALON (Ramsgate) proposed that the next President of the Association should be Mr. H. Smythe, of Maidstone.

Mr. J. ELDRIDGE (Oxford) seconded the motion, which was unanimously carried.

Mr. SMYTHE briefly thanked the members for the honour conferred upon him.

Mr. T. MAY (Richmond) moved the re-appointment of Mr. J. W. Helps to the secretaryship; and the motion was agreed to.

The HON. SECRETARY having acknowledged this renewed proof of the confidence of the members,

Mr. J. Thorman, of West Ham, and Mr. W. A. Walker, of Worthing, were elected members of the Committee, in place of those retiring by rotation; and Mr. C. E. Botley and Mr. W. H. H. Broadberry were appointed Auditors.

NEW MEMBERS.

The PRESIDENT moved, Mr. R. P. THOMAS (Ware) seconded, and it was agreed, that the following gentlemen should be elected members of the Association: Mr. J. Cowney, of Seaford; Mr. W. B. Randall, of Waltham Cross; Mr. E. T. D. Sapey, of Horsham.

Dr. L. T. THORNE, Ph.D., F.I.C., then read the following paper:—

ON OXY-OIL GAS (TATHAM'S PROCESS), AND ITS USE FOR PURPOSES OF ENRICHMENT.

Rather more than two years ago, I laid before the Incorporated Gas Institute the results of some preliminary experiments which I had made to test the accuracy of the claims

put forward by the patentee on behalf of the oxy-oil gas process; and, as a result of those experiments, I expressed my belief in its great value and future. At that time it was hoped that oxy-oil gas would very shortly be put to the practical test in a gas-works; but, from various causes—among which the disadvantage of the Syndicate owning the patents being located at the Antipodes, and the illness of the Syndicate's representative in England may be mentioned as the chief—its development has unfortunately been much delayed. Recently, however, very great progress has been made; and the introduction of the manufacture of oxy-oil gas on the practical scale at the Huddersfield Corporation Gas-Works, for use for purposes of enrichment, has again directed the attention of the gas world to the process. I have lately been enabled to resume my study of the Tatham process, and to carry out a long series of tests at Huddersfield on its practical working there; and I beg to-day to lay before you the results I have obtained up to the present.

The essence of the Tatham process lies in the addition to heavy hydrocarbon gases (from whatever source produced) of considerable quantities of free oxygen—this addition being preferably effected soon after the gases leave the retorts, and while they are still hot. The method of producing these hydrocarbon gases is not an essential point in the process, and almost any of the existing forms of oil-gas plant, or plant for producing gas from rich shales, might be used in connection with it; and with many, very favourable results would be obtained. It is found, however, that the heavier the hydrocarbon gases are, the greater is the benefit effected by the addition of the oxygen; and, as will be known to you all, the lower the temperature at which the oils are cracked, and the less heated retort-surface the vapours and gases have to traverse after cracking, the heavier is the gas produced. The less permanent character of the heavy gases thus ordinarily produced is more than neutralized by the increased stability given to them by the peculiar carrying power of the oxygen which is added; and the use of comparatively low temperatures for cracking obviates to a very large extent the difficulties of soot and pitch production which have militated so much against oil-gas making as hitherto usually attempted.

When to a heavy oil gas, which shows signs of smoking even when burning from a No. 0 Bray burner, oxygen is admitted while the oil gas is still hot, the illuminating power of the gas is raised. The maximum increase is obtained when from 12 to

18 per cent. of oxygen (according to the character of the oil gas) has been added. Further addition of oxygen, up to about 16 to 24 per cent., causes no further change in the actual illuminating power, though it renders the flame stiffer, whiter, and brighter to the eye, reduces the size of the dark zone, and improves the general shape and appearance of the flame. Further addition of oxygen gradually reduces the illuminating power of the gas. With low-quality (or lighter) oil gas, the percentage of oxygen which may be profitably added is considerably smaller. The increase of illuminating power with very heavy oil gas is 25 per cent., or even more; with lighter oil gas, rather less than this. The actual percentage of oxygen which is added in practice depends on the one hand on the quality of the oil gas made, and on the other on the use to which the oxy-oil gas is to be put. If it is to be used for the enrichment of coal or other gas, about the percentage of oxygen requisite to get the maximum increase in the illuminating power of the oil gas is added. If the oil gas is to be used for burning *per se*, a rather larger percentage of oxygen is employed. When dealing with petroleum or shale oils (which have as yet been mainly used), the percentage of oxygen in the oxy-oil gas may be broadly stated as 15 per cent. when made for enrichment purposes, and 20 per cent. when made for burning *per se*.

The actual illuminating power of oxy-oil gas depends, of course, on the oil or other material from which it is made, on the temperature at which the oil is cracked, and on whether the oil is only once run through the retorts, or whether the residuals are further used up by repeated re-cracking. To give a couple of instances of actual experiments: A high-class Scotch shale oil (Oakbank oil), such as is used by some of the railway oil-gas works, yielded, "once run," 74 feet per gallon of oxy-oil gas, showing an illuminating power of 98 candles. From this, there was about 40 per cent. of residuals. On further completely cracking these residuals, 44 feet more of oxy-oil gas per gallon of original oil were obtained, of an illuminating power of 71·2 candles. The total gas produced was thus 118 cubic feet of 88-candle gas per gallon of oil used, or about 30,000 feet of 88-candle gas per ton of oil. From a sample of Russian Solar Distillate of ·887 sp. gr., the yield was 103 cubic feet of 85-candle gas per gallon of oil, or 25,500 cubic feet of oxy-oil gas per ton.

These results can hardly be expected to be reached in practical working; and so my idea is that the most economical working in practice will be to produce an oxy-oil gas of about

80-candle power, of which at least 25,000 feet per ton would be obtainable from oil such as Russian Solar Distillate. Experiments point to the cheaper kinds of Russian and American oils (which are, however, at present not obtainable on the English market) giving even better results than the oils I have already mentioned. Furnace oils, and many other residual oils, may also undoubtedly often be profitably used in this process; but enough work has not yet been done on this branch of the subject to enable me to give actual and reliable figures.

In speaking of the candle power of this gas, it should be noted that all the readings are given from actual photometric tests taken on a 100-inch open bar photometer against a two-candle Methven screen—the oxy-oil gas being burned at a slow rate from an ordinary small Bray union-jet (Nos. 0 to 2), and the results obtained calculated to 5 cubic feet consumption. If compared (say) with 16-candle coal gas burning through a No. 5 or No. 6 Bray burner, the oxy-oil gas of 98-candle power would appear of at least eight or nine times the illuminating value of the 16-candle gas. In other words, while the average ordinary consumer, using flat-flame burners, really only obtains from 70 to 80 per cent. of the nominal illuminating power of ordinary 16 to 20 candle gas, he would with oxy-oil gas obtain the full nominal value.

In estimating the relative values of oil and oxy-oil gas, another important point must be taken into consideration. Careful experiments have shown that when, in the making of the gas, the residuals are worked up, not only is the illuminating power of the oxy-oil gas greater than that of the oil gas alone, but that the yield of oil gas (apart from added oxygen) from the oil is, under like conditions of working, from 10 to 15 per cent. larger when oxy-oil gas is being produced than when simple oil gas is made. The cause of this result is not easily explicable; but it probably lies in the retaining in the gaseous form, by the oxygen, of some of the hydrocarbons which would otherwise be condensed as residuals, and the consequent reduction of the amount of re-cracking of residuals required. Running parallel with this increase of volume there appears to be a smaller quantity of coke produced during the manufacture of oxy-oil gas than during that of plain oil gas.

The cost of this gas must, of course, largely depend on the price of the oil used. Russian Solar Distillate and Scotch "green" shale oil can now be obtained in bulk in England at about £3 per ton; and there is no doubt that, when a large demand for low-quality oils arises, arrangements will very

soon be made for bringing such oils into the country, and oil as suitable, if not more so, for the purpose will be obtainable at a far lower figure—probably £2 10s. per ton, if not even much less. In view of the present large Russian, American, and other oil-fields in operation, and the further known ones which have not yet been tapped for want of a market, the fear that the price will go up is absolutely unfounded. Based on the present price of oil, the cost of an 80-candle oxy-oil gas should certainly not exceed 3s. to 3s. 6d. per 1000 cubic feet into the holder. As the gas stands compression with much less loss of light than ordinary oil gas does, this should give oxy-oil gas a most favourable field in the lighting of railway carriages, &c. In fact, trials have already been successfully made in the lighting of tramcars and omnibuses.

In America, with suitable oil obtainable at about 20s. per ton, oxy-oil gas of 80-candle power should be manufactured at about 2s. per 1000 cubic feet; and there it should become—either *per se* or reduced to (say) 40-candle power—a formidable rival to the present coal gas and carburetted water gas on the one hand, and to the electric light on the other, as the light produced is very diffusive, white, and pleasing. It may also be very advantageously used in America for enriching water gas. Another good field for this gas in America should be the enrichment of the natural gas (marsh gas) which is at present used for fuel. Some experiments which Professor E. Frankland and I carried out in 1877* show that this gas when enriched with benzene, gives about 30 per cent. better results than either hydrogen, carbonic oxide, or water gas gives. One cubic foot of benzene vapour, when mixed with these gases, gave respectively: With hydrogen, 69·7 hour-candles; with carbonic oxide, 73·4 hour-candles; and with marsh gas, 93·2 hour-candles—the effect with water gas lying, of course, between those with hydrogen and carbonic oxide. Similar results would undoubtedly be found with oxy-oil gas. Many processes have already been tried for the production of illuminating gas from this natural gas; but have all proved failures, mainly from the want of carrying power of the enricher employed. By the addition of oxy-oil gas to the natural gas, a thoroughly permanent gas of high candle power could be easily and economically obtained.

In England, the largest field for oxy-oil gas in the immediate future lies undoubtedly in its use for enriching coal gas. It is on this ground that the present installation at Huddersfield

* See *Journal of the Chemical Society*, Vol. XXXIII., 1878, p. 93.

is particularly interesting to gas engineers, and that a short account of the installation, and of the results obtained therewith up to the present, may be acceptable to the members of this Association.

The plant at Huddersfield is designed to produce 200,000 cubic feet of oxy-oil gas per 24 hours; the intention being eventually to add 5 per cent. of oxy-oil gas to the whole of the gas supplied to the town, and thus give a very high-class gas of about 20-candle power. The oxygen plant, put up by Brin's Oxygen Company, has been working for some time. It is built in two independent sections, is capable of producing 30,000 cubic feet of oxygen per day, and is the largest oxygen producer ever yet erected. The oil plant will, when completed, consist of four or five bays, each bay containing 15 retorts. At present only one bay is in actual work, as it was thought advisable, in a new departure such as this, to very carefully try the system of retorts adopted in one bay before proceeding to the erection of the remainder. Slight improvements have been made in the mode of setting of the retorts and of their fittings, which will overcome some slight difficulties which have been experienced; and the completion of the remaining bays is now actively in progress. In each bay there are 15 cast-iron retorts, arranged in rows; the three upper rows being of four each, the bottom row of three. The retorts are 7 feet long; the twelve upper ones being 8 inches in diameter, and the three lower ones, intended for cracking the heavier residuals, 10 inches in diameter. The retorts, which are double-ended, are set at a slight fall (about an inch) towards the back; and they have some 5½ feet of heated surface between the furnace walls. The back covers, used for cleaning out, are fastened by clamps.

The oil is fed into the retorts by means of 2-inch feed-pipes, passing through the front retort-covers, and terminating about two-thirds of the way down the retorts. They are fastened to the front retort-covers by clamp flanges, so as to be easily removed for cleaning and duplicates are kept to replace them when so removed. The oil is supplied to these feeds by means of specially constructed syphons fitted with floats. These floats are so arranged that any stoppage in the feed-pipe, or excess of pressure in the retort, at once raises the float; and this, in rising, automatically closes the oil supply to that particular retort. The fittings and pipes are also arranged so that any one row of retorts may be shut off for cleaning. In the bay at present in operation, the three upper rows of retorts are fed with clean oil; the lower, and hottest, row with residuals. It

has been found, however, that this is not enough retort power for the cracking of the residuals; and, in the bays in course of erection, provision is made by which the next row of retorts may, at will, be fed with light residuals or with clean oil. The cracking temperature used is a dull red heat; the flow of oil being regulated to produce a canary-coloured gas. The best results are obtained by keeping a fairly large stream of oil flowing into the upper retorts, and re-cracking the considerable proportion of residual then obtained. The oxygen is admitted to the oil gas soon after the latter leaves the retorts, and while still hot. The admission of the oxygen is proportioned by a specially constructed meter, coupled to, and consequently controlled by, the oxy-oil gas station meter. This meter is so coupled that, for every 100 feet of oxy-oil gas passing the station meter, 15 cubic feet of oxygen are admitted through the oxygen meter to the warm oil gas. Arrangements have been made by which the oxy-oil gas may, at the will of the manager, be introduced directly into the coal-gas foul main, or be passed into a weighted holder, from whence it may be admitted into the purified gas just before the station meter.

It was hoped and anticipated that the first portion of the oxy-oil gas installation would have been finished and in work by the early part of the summer of 1893, and that thus, with the comparative leisure of that season of the year in a gas-works, and the small summer make of coal gas, it would offer full and easy opportunity for extended tests of the process. But—

The best-laid schemes o' mice and men
Gang aft a-gley

and it was well on in August before the plant was got to work. But even then difficulties were not over, for by that time the coal strike had commenced, and the usual sources for coal were cut off, the regularity of working very seriously interfered with in consequence, and the difficulty of obtaining reliable results correspondingly increased. Delays in the hope of a settlement of the strike proved futile; and it was therefore decided to carry out the tests without any further waiting, and to take special precautions to minimize the effect of any irregularities. I wish to take this opportunity of expressing my thanks to Mr. W. R. Herring, the Engineer and Manager of the Huddersfield Corporation Gas-Works, for the freedom with which he placed his works at my disposal for carrying out these experiments, and for the facilities he has given me with respect thereto.

The oxy-oil gas plant in work was in connection with one section of the coal-gas producing plant, the gas from which

passed into one holder. The oxy-oil gas could be introduced direct into the foul main, or, through a special small holder, be admitted into the coal gas after the latter left the purifiers. The enriched gas was tested between the station meter and the gasholder, where the oxy-oil gas and the coal gas had become thoroughly mixed whichever point of introduction of the oxy-oil gas was being employed.

In order to obtain really reliable results of the enrichment effects produced by the admixture of the oxy-oil gas with the coal gas, and to neutralize as far as possible the effect of irregularities, I decided to make each series of tests stretch over either one or two hours, and thus include a fairly complete cycle of gas making. A 60-inch open bar photometer, fitted with a two-candle Methven screen, was used for these tests; readings being taken every minute during the duration of the test. The enriched gas was burned in each case from a standard Argand burner. A number of these series were taken at different times, so as to get some hundreds of readings; and the average was calculated from the whole of these. But, in order to ensure that the coal gas average taken should certainly not be below the truth, and so too favourable to the oxy-oil gas process, all unusually low readings were in this case cut out. In the case of the enriched gas, no such excision was made. By working in this way, results were obtained which, I think it will be admitted, must very closely approximate to the truth, and in which any error that there may be will tell against the oxy-oil gas enrichment process. The results obtained were as follows:—

	Average Candle Power.	Number of Readings from which Average is Drawn.	Percentage of Oxy-Oil Gas in Tested Gas.	Average Gain in Illuminating Power per Cent. of Oxy-Oil Gas.
Unenriched gas . .	14·42	600*	—	—
Enriched gas . .	17·05	480	2·96	0·89 candle.
„ . .	18·07	120	4·51	0·81 „

* With low ones cut out.

During the carrying out of these tests, Durham coal (obtained under the exigencies of the strike) was being alone used in this section of the works; and I think gas managers will therefore admit that the figure of 14·42 candles is certainly not a low one for the unenriched gas.

The rapidly increasing make of coal gas in this section of the works, necessitated by the approach of winter and short days, made the carrying out of the tests with a high percentage of oxy-oil gas somewhat difficult; and only two series, of an hour each, could be made. In these tests, the jet photometer (fed with unenriched gas) was below the average; and the result

obtained is therefore undoubtedly rather lower than it should be. As a result of these experiments, we see that, for small additions of oxy-oil gas, the enrichment was at the rate of about 2¼ candles for 2¼ per cent. of oxy-oil gas; while for larger percentages certainly more than 4 candles are obtained for 5 per cent. added.

In addition to these tests, I had previously taken some hundreds of short-series tests, but abandoned them as not eliminating with such certainty the irregularity of working to which I have already referred. I may mention, however, that these tests fully confirmed the figures just given for low percentage. A large number of careful tests of the illuminating power of the total output of enriched gas were also made, when the plant was first started, and while Yorkshire coal was still being used in the coal-gas retorts. These tests, extending over eleven days, gave an average illuminating power of 22 candles for the enriched gas containing 6 per cent. of oxy-oil gas (the make of coal gas being then only about half what it was during my later tests). Assuming the illuminating power of the unenriched gas to be 16·5 candles—a figure rather above the average they had been previously obtaining under identical conditions of working and coal—the enrichment comes out at 5·5 candles for 6 per cent. of oxy-oil gas. While, since the standard of comparison was not estimated absolutely concurrently with the enrichment, this figure cannot perhaps be looked upon as absolutely certain, it is undoubtedly not far from the truth, and confirms what I have said as to the figures of my large percentage enrichment tests already given being probably rather low.

While, as previously stated, these enriching tests have been made with the Argand burner, as the official test to which most gas managers must conform, the influence of the enrichment when the gas is burned in the flat-flame burner in general domestic use is of importance. Numerous tests have shown that the actual increase in candle power is as high when tested in the flat-flame burner as when tested in an Argand. In consequence, the percentage increase is much larger with the flat-flame burner. Thus, for instance, a 16-candle gas enriched to an 18-candle gas would show an increase in the Argand burner of 12·5 per cent. Burnt from a flat-flame burner, however, the original gas would give about a 12-candle flame; while the enriched gas would read 14 candles, or an increase of 16·6 per cent. Thus, while the gas manager was conforming to official requirements, he would apparently benefit his customer to a much larger degree.

Some enrichment tests were carried out with plain oil gas made under identical conditions to the oxy-oil gas. Unfortunately, Yorkshire coal was at that time being worked in the sloping retorts; Durham coal still being used in the horizontal retorts of this section. This necessitated fresh estimations of the unenriched gas; and, owing to the limited number of tests which could be made, the resulting averages have not quite the same degree of accuracy as those obtained with oxy-oil gas. Still the results are certainly within one or two tenths of a candle of the truth. The results obtained were as follows:—

	Average Candle Power.	Number of Readings from which Average is Deduced.	Percentage of Oil Gas in Tested Gas.	Gain in Illuminating Power per Cent. of Oil Gas.
Unenriched gas	15·92	120	—	—
Enriched gas	17·79	150	3·02	0·61 candle.

This result, agreeing as it does with numerous tests which I have made on a small scale, proves conclusively, in my opinion, that the enriching power of oxy-oil gas is much greater than that of oil gas made under similar conditions, but to which no oxygen has been added.

It has been mentioned that arrangements have been made at Huddersfield to enable the oxy-oil gas to be admitted to the coal gas either at the foul main or after the purifiers. With a view to try and determine whether either of these modes has an advantage over the other in enriching results, the oil gas in the low-percentage experiments was in some tests admitted at the one point, in others at the other point. No appreciable difference could, however, be observed in the results obtained. In the high-percentage tests given in the table, the oxy-oil gas was in each case admitted through the special holder to the purified gas; while in the early 6 per cent. enrichment tests mentioned, the oxy-oil gas was added at the foul main. This would tend to point to the admission at the foul main giving the better results; but the lower result when working through the holder may also be partly accounted for by the possibility (as I shall explain later) of the oxy-oil gas made into the holder containing traces of air.

If the enriching effects are the same whether the oxy-oil gas is admitted to the crude or the purified gas, the mode to be selected will depend on the particular needs of each gas-works. The admission by the foul main has the advantage of doing away with the need and cost of a separate exhauster and gas-holder; while, on the other hand, admission to the purified gas gives the manager greater facility in regulating the enrichment

as may be needed. In connection with the good results got at Huddersfield with foul-main enrichment, it must be borne in mind that a small quantity of oxygen is being added there to the crude coal gas before the purifiers, to revivify the latter *in situ*. Where no such use of oxygen is made, the purifiers would undoubtedly abstract some of the oxygen from the oxy-oil gas, and detrimentally affect the enrichment results, unless a larger proportion of oxygen were added to the oil gas.

Turning for a moment to the question of the cost of enrichment by oxy-oil gas, we find very favourable results. Assuming 15-candle gas as costing 14d., we get—

$$\begin{aligned} 97{\cdot}5 \times 14\text{d.} &= 1365 \\ 2{\cdot}5 \times 42\text{d.} &= 105 \\ \hline 100{\cdot}0 \times 14{\cdot}7\text{d.} &= 1470 \end{aligned}$$

This gives a cost of 0·7d. for a gain of 2¼ candles, or 0·31d. per candle enrichment, or less than ⅓d. This figure is far below the cost of enriching by any process at present in use.

Several kinds of oil have been tried at Huddersfield; Russian Solar Distillate and common Scotch "blue" oil, both of ·87 to ·88 sp. gr., giving better results than oil of lighter gravity. The yield of oxy-oil gas has been 100 cubic feet per gallon of oil, or about 25,400 cubic feet per ton. I have already mentioned, however, that insufficient retort power for cracking the residuals was provided in the first bay, and in consequence some residual has been wasted as regards oil-gas making—it has been used on the coke as boiler fuel. When the new bays are working, and all the residuals can be used up, the above-mentioned yield will certainly be increased. The coke produced has not been more than 5 per cent. of the oil used.

Similar difficulty has been experienced in getting, up to the present, the true illuminating value of the oxy-oil gas made; for, when working into the special holder, a special exhauster has to be employed. This, while suitable for the 8000 to 10,000 cubic feet per hour for which it is intended and arranged, becomes very difficult to regulate to a steady gauge when the make is only (say) about 1500 cubic feet per hour. In consequence, the retorts and condensers are occasionally temporarily placed under suction, with the probability of small quantities of air being drawn in, and consequent reduction of the illuminating power of the oxy-oil gas. When working into the foul main, connection is simply made by a valve with the coal-gas mains before the general exhauster; and the oil-gas retorts can then be maintained under a steady level gauge. This may, as already mentioned, be in part the cause of the somewhat lower

results obtained with the 4·5 per cent. enrichment tests. The gas tested from the holder showed a candle power of from 65 to 70—a much lower result than should be obtained from Solar Distillate or "blue" oil, or than will certainly be obtained when more oil-gas benches are in work.

Many tests of the stability of the oxy-oil gas *per se* were made; and all showed the gas to be remarkably permanent. In one case, about 500 cubic feet of oxy-oil gas of 67·7-candle power were left in a 3000 cubic feet holder during a cold, though not actually frosty night; but photometric tests showed no loss of illuminating power. A prolonged test was made, during a spell of cold weather, on about 500 cubic feet of oxy-oil gas, which was kept for a week and tested each day. The results were as follows:—

Date.	Time of Test.	Candle Power.	Kind of Weather.
Oct. 30 ..	5.30 p.m. ..	64·8 ..	Keen frost.
„ 31 ..	11.30 a.m. ..	64·2 ..	Boisterous, cold, and wet.
Nov. 1 ..	5 p.m. ..	63·6 ..	Moderately cold.
„ 2 ..	11.30 a.m. ..	63·5	Mild.
„ 3 ..	10 a.m. ..	63·5	
„ 4 ..	5 p.m. ..	62·7 ..	Keen frost.
„ 5 ..	3 p.m. ..	62·0 ..	Keen frost during night; wet morning.
„ 6 ..	10 a.m. ..	61·2 ..	Keen frost.

Thus, with this very severe treatment—the gas in a 3000 cubic feet holder being, in the end, reduced to about 300 cubic feet—the loss during seven days of cold weather was only 3·6 candles, or 5·55 per cent. All these tests prove oxy-oil gas to be extremely stable; in fact, more so than coal gas.

No really thorough tests have yet been possible at Huddersfield of the travelling powers, through long distances of mains, of coal gas enriched with oxy-oil gas. Mr. Herring tells me, however, that, during the time the coal gas containing 6 per cent. of oxy-oil gas was being supplied to the town, he could detect no loss of illuminating power at his house, about two miles from the works. But numerous tests on the stability of coal gas enriched with oxy-oil gas during the cold weather of last winter leave no doubt in my mind of the result of practical working. The coal gases used varied between 12 and 16 candle power; and these gases were enriched with 5 as well as with 10 per cent. of oxy-oil gas of about 80-candle power. The illuminating powers of the unenriched and of the 5 and 10 per cent. enriched gases were all carefully tested on the photometer, and then the three gases were left over water, in 6-feet bell holders, for two days; being subject in the meanwhile to great

changes of temperature, and at times to temperatures below freezing-point. These conditions were very severe—probably far severer than any to which coal gas is subjected in Great Britain. Several such series of tests were taken, and the average loss of illuminating power was as follows:—

For the unenriched gases . . . . . 1·35 candles.
„ gases containing 5 per cent. of oxy-oil gas . 0·95 candle.
„ „ „ 10 „ „ . 0·50 „

These results show that not only is the enriched gas not less stable than the unenriched, but that enrichment by oxy-oil gas even increases the stability of the original coal gas.

Summarizing the results I have just described, we find that—

(1) The addition of oxygen to oil gas (preferably while the latter is still hot) not only increases the illuminating value of the oil gas when it is burned *per se*, but also when it is used for purposes of enrichment.

(2) Oxy-oil gas is a highly permanent gas, and, when used as an enricher of coal gas, actually increases the stability of that gas.

(3) Enrichment of coal gas by oxy-oil gas would cost about ⅛d. per candle per 1000 cubic feet.

It is needless for me to review the relative costs and merits of the various modes of enriching coal gas at present in use, or which have been suggested, as this subject has been so often discussed of late, and is well known to gas managers. The facts which I have been able to lay before you speak for themselves; and, in my opinion, they undoubtedly place oxy-oil gas at the head of the enriching processes yet known, and fully justify the favourable view of the process which I enunciated in my former paper.

[At the conclusion of the paper, Dr. Thorne, by means of some cylinders of oxy-oil gas and coal gas, demonstrated to the members the difference in the light afforded by them. In doing this, he remarked that the cylinders of oxy-oil gas contained respectively 15 and 20 per cent. of oxygen, compressed to a pressure of about eight atmospheres. He was able to show these in comparison with ordinary coal gas—burning, for instance, through a No. 5 Bray burner. There was not a good pressure of gas; so that the result with the ordinary coal gas was not quite as it should be. He showed the oxy-oil gas burning through No. 1 Bray burners, and the coal gas burning through No. 5 Bray burners. The pressure was only about 8-10ths of an inch; but the gas was passing through a meter, so that the members could see roughly the relative rates of

consumption of coal and oxy-oil gas. Of course, he said, gas containing 15 per cent. of oxygen lost under compression about 10 per cent. of its light. He had also a gas containing 20 per cent. of oxygen, which he would burn in larger (No. 4) burners; and these would give an idea of the character of the flames with the greater percentage of oxygen. Of course, these flames were rather too large for an oil gas. He had chosen a No. 4 Bray burner in preference to a No. 3 (which would have suited the oxy-oil gas better), because he wanted to turn on the coal gas to this burner in place of the other; and though the test was then against the coal gas, it was not so much against it as if they were using a No. 3 burner. They would see by this the character of the large flame; and it would be noticed that one characteristic was the much smaller sized dark space compared with the size of the flame than in the case of coal gas. This oxy-oil gas would burn with a much pleasanter flame from a No. 3 burner. He might mention that, with the gases burning from the same burners and under the same pressure, the relative rate of consumption would be about 5 cubic feet of oxy-oil gas to 7 cubic feet of coal gas. It would be seen by the meters that the quantity of coal gas burnt was about 10 cubic feet, whereas the amount of oxy-oil gas consumed was about 4 feet; so that they were burning about two-and-a-half times as much coal gas as oxy-oil gas. The difference, however, in the illuminating power was much to the advantage of the latter. Under favourable conditions, when made and burnt carefully, the result was eight or nine times in favour of oxy-oil gas.]

Discussion.

The PRESIDENT said that, whether judged by the importance of the subject, its careful preparation, or the number of points with which it bristled, the paper which they had just heard was a most interesting one; and the best compliment they could pay to Dr. Thorne, and the best thanks they could give him, was that they should adequately discuss the subject.

Mr. W. A. VALON (Ramsgate) said Dr. Thorne and he had been associated together for a long time; and he knew him to be such a careful experimenter, and so anxious as to his facts, that he felt a certain amount of hesitancy, reading this paper for the first or second time, in coming to a conclusion not quite on all-fours with the author. If the facts really were as they appeared to him to be in the paper, he could not quite follow the whole of them; and he could not yet bring his mind to think there was any great share of the good results due to the

oxygen itself. He should have liked very much indeed, if it had been possible, to have had the effect of mixing oil gas pure and simple—without oxygen—with the coa gas; and, in the next place, he should have liked to have had it stated in the paper what was the amount of oxygen found in the purified gas after it had passed to the holder, and before it was sent into the mains. He found Dr. Thorne said he mixed with the Huddersfield gas 5 per cent. of oxy-oil gas; and this 5 per cent. of gas had to contain 15 per cent. of oxygen. Now, taking the make of gas as given to him (Mr. Valon) at Huddersfield, or any make, if it was to be 5 per cent. that had to be mixed to raise the illuminating power to a certain point, then the 15 per cent. of oxygen mixed with the 5 per cent. of oxy-oil gas made for the whole 0·75 per cent., or rather less than he was using at Ramsgate for purification alone. As he had remarked, he had proved, certainly to himself, by careful experiments, that there was no doubt a slight excess of oxygen in the purified gas was advantageous; and it must be a slight proportion. But in this case his mind was perfectly clear that, if only that quantity of oxygen was put in with the oxy-oil gas, and introduced into the foul main, not any of it would find its way into the gasholder. He saw later on in the paper that Dr. Thorne admitted it was possible a quantity would be taken out in the purifiers. If the 5 per cent. of oxy-oil gas was introduced in the foul main, then it was considered that nothing would be wanted further for the action of the purifiers; but, in that case, he (Mr. Valon) submitted to Dr. Thorne that the whole of the oxygen put into the foul main would be abstracted in the purifiers, and there would be none left in the gasholders. This was why he should have liked an analysis of the gas, so as to know how much free oxygen there was in it. Referring to the system of putting in oxygen in the foul main, of course the members were aware that he (Mr. Valon) had made many hundreds—he was going to say thousands—of experiments in that direction. He found that, while at Ramsgate, and at other works, they were putting in 0·6 per cent. of pure oxygen for purification when the sulphur equalled 600 grains, if they put in this oxygen at the foul main, instead of at the entrance to the purifiers, they used a larger amount with a very much less result. Now they saw the bearing of this point. He would show how he was able to prove it by an absolutely practical experiment made within the last two years. Two years ago, when the Association visited Ramsgate, they were putting oxygen into their gas—drawing it through the exhauster; and they were exhausting at that time through the

condensers and the scrubber. The consequence was they were able to take their oxygen in at the exhauster, and not send it through the washer and condenser to the purifiers. In the course of making some alterations about two years ago, they had to remove the scrubber and condenser, and they had to put them on the other side of the exhauster. The result was they had to increase their percentage of oxygen to such an extent that the oxygen apparatus could not produce the quantity they required for purification. A large amount of the oxygen was absorbed by the scrubber. He presumed that, by putting the scrubbing, washing, and condensing apparatus in front of the oxygen, they lost a large quantity of it; and they then introduced a steam jet to bring the oxygen into the inlet of the purifiers. Directly they did this, they went back to the same quantities as before. What he wished to point out was that this raised in his mind a doubt as to whether there was anything left of the oxygen, mixed with the oxy-oil gas in the foul main, after it passed the purifiers; and he should like Dr. Thorne to give them the amount of free oxygen that was in the gas after it reached the holder.

Mr. W. R. HERRING (Huddersfield) said that Mr. Valon had been making some remarks in comparison of oil gas alone and the oxy-oil gas. He might say that he had ventured once to run the apparatus with oil, and shut off the oxygen; but within 24 hours they got so thoroughly choked, that he thought it better, so as not to add further to his troubles, to let the oxy-oil process, as they worked it at Huddersfield, be judged by the ordinary oil-gas processes as used in other towns. They found they could not keep their apparatus clear when making oil gas alone. Another thing was they found that in the condenser they got among the condensation a very light spirit, highly volatile; and he thought that, by usually running the plant for oxy-oil gas, and then for one day using it as a simple oil-gas plant, there was every possibility that this light vapour was taken up by the oil gas, and so enriched—thus giving a result more favourable to the oil gas than otherwise would be the case. With regard to Mr. Valon's remarks respecting the admission of the oxy-oil gas in the foul main, he might say that, whenever they were using it in the foul main, they admitted, practically speaking, 0·8 per cent. of oxygen at the exhauster inlet. With regard to the process itself, perhaps some of the gentlemen present were at the meeting a few weeks previously of the Society of Engineers, when Professor V. B. Lewes read a paper on "Gas Substitutes;" and, in the course of the discussion, he

(Mr. Herring) referred to what they were doing at Huddersfield.* They had then been running the oxy-oil gas process for about a fortnight. It was still working with equal satisfaction; and the results now quoted by Dr. Thorne fully confirmed those obtained at the beginning. As soon as they had the large plant working, he was in hopes of getting one candle per cent. of enrichment. He might also make a few remarks with reference to the difficulties met with during Dr. Thorne's experiments. They had had considerable trouble in their neighbourhood with respect to coal. They were in the habit of using a large proportion of Silkstone—it being the cheapest for them. But since their stock had run out, they were obliged to substitute a supply from Durham, which was fully 2 candles inferior to the coal they had been working; and there were days and parts of days during which they were using nothing but Durham coal, and then they would take in perhaps 50 or 60 tons of Yorkshire coal. At the same time, any very low readings which were obtained with the unenriched gas were struck out, in order to tell rather against the process than in favour of it.

The PRESIDENT said he was sure Mr. Herring would kindly supplement his remarks on one or two points which seemed to be of interest. One was with reference to his inability to make the experiments which Dr. Thorne had touched upon in his paper—of working an oil-gas plant independently of the oxygen. He understood he had some difficulty, owing to the apparatus blocking up. In what way did the apparatns employed for making oil gas give such trouble? Then, with regard to the point at which the oxy-oil gas was mixed with the coal gas, Mr. Herring got over the difficulty of the absorption of the oxygen by the purifiers by the admission of 0·8 per cent. of oxygen, which the purifiers absorbed, and therefore left the oxy-oil gas perfectly free. He should like to ask whether Mr. Herring used lime for purifying, and whether he was working for sulphur compounds; or whether he was using oxide, and only extracting the sulphuretted hydrogen.

Mr. HERRING said, regarding the first question, as to the choking of the apparatus when running with oil gas alone, he might say that they had no hydraulic main. They collected the gas, and took it direct to the inlet of the condenser. Immediately at the top of the retorts, in front of the arch, they had a rising pipe, which was the only ascension-pipe. There was a bend at the top about 8 feet from the ground. From there they probably

* See *Journal of Gas Lighting*, Vol. LXII., pp. 629, 675.

had 8 to 10 feet of pipe leading to an annular water condenser. They found the plant became choked up with a thick tar when running with the oil gas alone; and they had had numerous difficulties one way and another. He had had no time to devote to small details; and so he did not think he need trouble to run oil gas alone. There were other processes by which they could compare the oxy-oil gas. The plant was choked up principally with tar; but probably that might have been soot saturated with the condensed oils. With regard to the admission of oxygen to the purifiers, he had forgotten the pith of the President's observations.

The PRESIDENT said, as he understood Mr. Herring's remarks, 0·8 per cent. of oxygen was admitted apart from the oxy-oil gas, and this oxygen was absorbed by the purifiers. Therefore, the purifiers did not reduce the value of the oxy-oil gas. Did Mr. Herring use oxide of iron or lime purifiers? Supposing oxy-oil gas were admitted in the foul main in using lime, they would want to put so much sulphuretted hydrogen in the lime vessels that they would not be able to purify for sulphur compounds at all.

Mr. HERRING said they had four oxide and two lime boxes, and the sulphur compounds ran between 25 and 30 grains; they did not run over when using the oxygen. Practically speaking, the results obtained were the same whether working with a percentage of oxygen in the purifiers, or admitting the oxy-oil gas into the foul main, or *per se* into the meter.

Mr. FRANK LIVESEY (London) said that the only thing to which he wished to refer in connection with the paper was that they all ought to investigate this method of enriching gas at ¼d. per candle per 1000 cubic feet, because he believed Dr. Thorne had proved it to his own satisfaction. If this was the case, he thought they ought all of them to investigate it—this very low rate being cheaper than the enrichment of gas had ever been done at before. But this also brought upon them the responsibility of making not only oxygen but also oil gas. Most gas managers had quite enough to do at the present time; and he did not think they would want to add to their troubles. He was therefore afraid this would deter them, if they consulted their own feelings as to whether or not they should adopt this plant, which had been put before them in a very favourable light. The point he wished to bring out was that he believed nothing had been added for interest on the plant. [Dr. THORNE: It has.] He did not gather that from the paper. Of course, this simplified it still further.

Dr. THORNE: The oxygen royalty has been included, but not the process royalty.

Mr. LIVESEY: At any rate, it would not add much to the ½d.

Dr. THORNE: I have not gone into the business in that connection; but, from what I know of the people who have this matter in hand, they would not add a royalty which would seriously interfere with its introduction.

Mr. LIVESEY: Did I understand you that the oxy-oil gas was put in before or after the purifiers?

Dr. THORNE: Both.

Mr. LIVESEY: Is the gas perfectly free from sulphuretted hydrogen?

Dr. THORNE: Yes.

Mr. LIVESEY: Then, from the discussion which has followed the paper, I do not see why the oxy-oil gas should be put into the foul gas at all, because you must lose some of your oxygen.

The PRESIDENT: That is got over at present by putting in sufficient oxygen to absorb all the sulpuretted hydrogen.

Mr. C. GANDON (Lower Sydenham) said the paper was, to him, exceedingly interesting, because it cleared up a doubt that was in his mind before as to what really this oxy-oil gas process might be. Dr. Thorne started by saying that it practically resolved itself into the addition of oxygen to the gas. He had had the opportunity of seeing the small apparatus which was at work in London, and the same idea struck him—that the only principle involved was the addition of oxygen. He thought this was what the paper dealt with; while the oxygen rendered the gas more permanent, and also prevented the deposition of such tarry matters as Mr. Herring had referred to. He was not in a position to express an opinion on this point; but, if did that, it would be a great advantage, because, in all the experience he had had of making gas from oil, this had been one of the difficulties—the choking of the apparatus. If the oxygen would prevent this, that alone would be worth using it for. As Mr. Livesey had pointed out, this process involved two sets of apparatus—the oxygen-generating plant and the oil plant. This was enough to frighten some of them, as perhaps it had frightened Mr. Livesey. Gas managers had now pretty nearly enough to do to make coal gas; but still he thought they would all follow these experiments at Huddersfield with a great deal of interest, though he did not think that as yet they were beyond the experimental stage. When Mr. Herring was able to enrich all his gas by this process, he (Mr. Gandon) would like to pay him a visit; but at present, with the diversity of coal which

he had been using, and one thing and another, he hardly thought Mr. Herring had got beyond the experimental stage. As he gathered from the paper, the advantage so far as illuminating power was concerned in using oxygen was not so very great. He thought that in one place Dr. Thorne gave about 0·83 of a candle per cent. of the oxy-oil gas—5 per cent. of oxy-oil gas gave 4 candles increase of illuminating power. Now, if he worked it out with this experiment which Dr. Thorne gave on plain oil gas, he (Mr. Gandon) made out that 5 per cent. would yield about 3 candles increase of illuminating power. Therefore, there was about 1 candle in favour of the oxy-oil gas; or (say) 25 per cent. He did not know whether he was correct in looking at it in that light; but, if not, perhaps Dr. Thorne would put him right. One other point was as to the quantity of coke which was the ultimate residual that was produced. He had heard that in the Young process, for instance, they had something like 25 per cent. of coke left; but now in this process there was only 5 per cent. What was the reason of this difference—was it due to the oxygen? In connection with this oil-gas question, there was another little point; but he did not know whether it was altogether pertinent to the paper. It was the effect on bulk of adding rich gas to poor gas. Suppose they took 100 feet of ordinary gas, and added to it 10 feet of 80-candle gas, would they obtain 110 feet of gas? His experience was that they would not. Mr. Watson, who was present, had been making some crude experiments on this point; and perhaps he could give the members some information about them. These experiments pointed to the fact that one did not get 10 feet increase. In Field's "Analysis," it was stated that 75 feet of oil gas could be obtained from a gallon of petroleum spirit; but would they get 75 feet more to sell? He thought not.

Mr. J. C. Watson (Lower Sydenham) said he had been trying some crude experiments for the purpose of seeing what the result would be of adding a gas of high specific gravity to poor gas. He took some portions of carburine vapour, and he found that, by adding 2, 5, or 10 per cent. to poor coal gas, he did not get the volume with which he started. He worked in this way: He took 99 volumes of gas, and put in 1 volume of carburine vapour. After this had been stored for 24 hours, there was a decrease of ½ per cent. in the bulk. Then he took 98 volumes of coal gas, and added 2 volumes of carburine vapour; and he again found a decrease in the bulk after being stored for 24 hours. But when he took 90 volumes of coal gas, and got up to 10 per cent. of carburine vapour, he found there

was a diminution in bulk of nearly 4 per cent. He had very crude apparatus to deal with; but he checked the results by the eudiometer, and he found the returns were practically the same with the two appliances. He did not place very much reliance upon the results, because they were rather more than he expected. But still it would be interesting if Dr. Thorne could enlighten the members as to what the percentage of added gas would be—that was to say, whether, by the addition of oxy-oil gas, they got an absolute volume or not.

The PRESIDENT remarked that the experiments which had been carried out by Mr. Watson depended very much for their accuracy upon the means adopted for measuring the portion of carburine vapour added to the original volume of coal gas.

Mr. WATSON said he took a glass measure which contained about 50 cubic inches of coal gas. This was a graduated measure, and he put it over water in the form of a gasholder; and the carburine vapour was allowed to percolate into the holder. A reading was then taken; and then the whole thing was allowed to cool for 24 hours, after which another reading was taken.

Mr. J. W. HELPS (Croydon) said that some two months ago he obtained an introduction from a friend to the Oxy-Oil Gas Company. Very shortly afterwards, he went to their offices in Salisbury Square, where they had an experimental plant; and what he saw there was very similar to what Dr. Thorne had shown them that day. After seeing photometrical tests, and reading reports in which it was stated that gas could be enriched at a cost of ½d. per candle, it struck him that the process was worth looking into. He brought the matter before his Directors, and obtained their permission to investigate it. During the past five weeks, he had had a good many opportunities of doing this; and he had to thank the Oxy-Oil Gas Company for the facilities they had afforded him, both in London and at Huddersfield. He spent some days at the Salisbury Square testing-place in carrying out a series of experiments; and he immediately followed this up by paying a visit to Huddersfield. He could bear out what Dr. Thorne had stated as to his experiments having been carried out for some time under considerable difficulties. Since then he had been back in Salisbury Square making other experiments; and perhaps the members would think it rather strange that, having had a fair amount of experience, he was not yet prepared to lay before them figures proving the matter one way or the other. It seemed to him that a subject of this kind ought to be tackled in such a

way that a certain amount of definiteness could be arrived at in five weeks. He had not finished his experiments; and therefore he could only give the results rather generally than with any detail. Both at Huddersfield and at the Salisbury Square testing-place, he had made oil gas and oxy-oil gas; and he had, over a considerable number of tests, compared the results. He could safely say this, that they seemed to bear out very nearly the results that Dr. Thorne had given them in his paper—that was to say, that, with 5 per cent. addition of oxy-oil gas, he had obtained an enrichment varying from 3¼ to 5½ candles; while, with oil gas alone, he had never succeeded in reaching more than 3¼ candles enrichment. It was quite possible at times, however, to find that they got experiments in which oil gas would show a better result than even oxy-oil gas. But it would not do to depend upon one experiment alone; and he had given roughly, in the figures just quoted, the mean result of the tests he had made. There was one point he should like to mention with reference to a rather curious experiment that he had carried out at the offices in Salisbury Square. He took some ordinary enriched gas, and divided it into two portions, and put them into two small holders. He carefully tested them, and ascertained their candle power. He then added to one of them 5 per cent. of oxy-oil gas, and allowed it a few hours to diffuse; and he then found he had added a little under 4 per cent. of enrichment. He then left these two holders sealed up (in sealed and stamped rooms) for some days; and, when he returned, he found the coal gas had lost a considerable amount of its illuminating power, while the oxy-oil gas, with the 4-candle enrichment, had only lost about 0·4 candle. He then added to the impoverished gas 5 per cent. of oxy-oil gas; and from this he obtained a result infinitely higher than anything he had realized before. He did not want to say that the coal gas had deposited certain hydrocarbons on the face of the water or the sides of the holder which the oxy-oil gas picked up, and allowed to be introduced as illuminating power; but the fact remained that he obtained as enrichment something like 5½ candles. He was only at Huddersfield three or four days; but while he was there he tested the oxy-oil gas both ways—he admitted it at the inlet of the meter, and also on the hydraulic main. Though he should not like to say, with a small number of experiments, that they were perfectly correct, yet he found in those experiments a higher result when he admitted the oxy-oil gas at the hydraulic main than when it was admitted at the meter. In conclusion, he could not help saying that it seemed to him a great reproach

to an industry so large as theirs, that they had not at their disposal a gas-works based on commercial principles in the first place, but with its main object that of providing apparatus and skilled assistants, chemists, and engineers, who were prepared to take part in and thoroughly test such processes as the one before the members, but under better circumstances than those in which Dr. Thorne had been working. There must be something in processes of this kind when they had a chemist like Dr. Thorne bringing before gas managers such a paper as that just read. Why should not gas companies combine together to provide the means for testing these processes?

Dr. H. W. SALOMONSON (Amsterdam) said that in his paper Dr. Thorne had given them a great number of facts and figures which led him to conclude that the arguments against the oxy-oil gas process could never be maintained; but the arguments against it convinced him that there was a difference of opinion as to the essential question, What is oxy-oil gas? Dr. Thorne always spoke of the gas as it was made by the Tatham process; while Professor Lewes made a mixture of oil gas and oxygen. Professor Lewes took oil gas and tested it; then mixed it with oxygen, and tested it again; and then enriched poor coal gas with both. But it was impossible to test oil gas the moment it came out of the retort, before it had passed the condenser, and while it was hot; and yet in the Tatham process it was claimed that the oxygen had to be mixed with the oil gas in that state, in order to obtain all the advantages of the process. If this fact was not taken into consideration, they could not expect results which would be obtained by the oxy-oil gas; and differences would of course arise. He had recently had to investigate the oxy-oil gas for a Syndicate, and his own opinion was that there was a great difference between the production of oxy-oil gas and making a mixture of oil gas and oxygen. He had made oil gas without oxygen, and obtained the following results (taking the oil in pounds and not gallons):—

	Gas. Cub. Ft.		Candles.		Candles.
1 lb. of oil gave	8·965	of	61·6	=	110·5
„ „ „	10·0	„	57·7	=	115·5
„ „ „	11·1	„	51·2	=	113·5

It would be seen that there was a considerable difference in the illuminating value of the gas. In one experiment, it was as low as 51·2 candles, while in another it was 61·6 candles; but there was very little difference as to the number of candles per pound of oil. Then he made (as far as possible under entirely similar conditions) oil gas, but added oxygen at the moment the gas

was coming out of the retort, and while it was hot. The oxygen was added to the extent of 15 per cent. of the volume of the gas expected to be obtained; and the following were the results:—

	Gas. Cub. Ft.		Candles.		Candles.
1 lb. of oil gave	13·06	of	66·5	=	173
„ „ „	12·66	„	68·7	=	174

These figures showed that the addition of 15 per cent. of oxygen gave an increase of more than 50 per cent. of illuminating value to the gas. These results were not obtained by making a gas of higher illuminating power, as, for instance, he made an oil gas of 61·5-candle power, and an oxy-oil gas of 66-candle power, which was only an increase of 8 per cent. of illuminating power. This meant that the oxy-oil gas was made at a higher temperature probably than the oil gas, yet they obtained an advantage of 50 per cent. increase in illuminating value. In the second experiment, which was perhaps made at a somewhat higher temperature, he produced a larger volume of gas, and yet the number of candles produced from 1 lb. of oil was the same, but was, in fact, 50 per cent. higher than he found in making experiments on oil alone. He made this point because he thought that Dr. Thorne seemed to find a great deal in the fact that oxy-oil gas had a considerably higher value than the oil gas, and that there was an advantage in making the oil gas at a lower temperature. The 50 per cent. increase was not, of course, pure profit, as they had to add 15 per cent. of oxygen; but he made out the value of the oxygen as about equal to that of 55 to 60 candle oil gas. They could calculate that 1 lb. of oil gas equalled 115 candles, and adding 15 per cent. to it they obtained 132·5 candles. Taking the gas from 1 lb. of oil *plus* 15 per cent. of oxygen, they found 173 instead of 132 candles; and this was a pure profit in value of 30 per cent. increase in the candles by the addition of oxygen. He thought this was the way to test the value of the addition of oxygen as far as the formation of the gas was concerned. These figures showed that the Tatham process meant something more than the making of a simple mixture of oil gas and oxygen; and he would oppose to the experiment required by Professor Lewes this one: Take oil gas, test it, mix it with 15 per cent. of oxygen, test it again, and then see whether or not the mixture had increased by as much as 50 per cent. in illuminating power. He did not suppose it would show such an increase; but it would indicate that there was a certain difference between making oxy-oil gas and a mixture of oil gas and oxygen. Dr. Salomonson proceeded to refer to the experiments made by Wibel

some 15 years ago, which showed that, if air was mixed with gas as in the Bunsen burner, the illuminating power of the flame was lost—not on account of the oxygen in the air, but in consequence of the debasement of the temperature in the inner part of the flame. Wibel said: "It is extremely difficult to annihilate the illuminating power of the flame by oxygen, and that only takes place if such an excess of oxygen is added so that the flame would be cooled. Under favourable circumstances, there will be a considerable increase in illuminating power." Such observations would make it *à priori* improbable that the addition of 5 per cent. of oil gas to poor coal gas would debase the illuminating power of the flame. But the question could be decided by experiment; and to compare the enriching power of oil gas, they had to know whether these gases developed their full illuminating power in the enriched gas, or perhaps more or less. He had found that, if coal gas was enriched with oil gas, the illuminating power of the mixture was only very little higher than would be expected by calculation. But by making a 12½-candle coal gas, and then adding 5 per cent. of oxy-oil gas of 66-candle power, they could calculate upon a gas mixture of 15·3 candles certain. He could not therefore agree with Professor Lewes that the oxy-oil gas would overdo the combustion; and he thought his figures clearly showed that the oxy-oil gas had considerably more enriching power than would be calculated from the photometric tests of the gas *per se*. Considering this fact, in addition to the 50 per cent. increase in illuminating power which was obtained by adding 15 per cent. of oxygen, he was sure that the oxy-oil gas process was a great improvement; and he could understand the good results obtained at the Huddersfield Gas-Works. But a conclusion had been come to here which he did not think was entirely right. They had obtained very low figures at Huddersfield and in Salisbury Square as the cost of enrichment for oxy-oil gas; and these had conduced to comparisons of several other enriching processes with the oxy-oil process, in favour of the latter. Before concluding, he wished to make a distinction between the oxy-oil gas process and the Tatham process. He considered the Tatham process to be a new principle that could be adopted in a great number of cases —the addition of oxygen making a rich permanent gas from liquid hydrocarbons. Dr. Thorne had proved the value of this principle in one special case—in the oxy-oil gas process; and he would agree that he had proved that no other enriching process at present known could enter into competition with

oxy-oil gas in regard to cost of enrichment. But he understood that it was to the Tatham process—to the addition of oxygen—that they were indebted for these results. Would it not, he asked, seem very probable that the same advantages could be obtained in all processes and in all cases where, just as in the oxy-oil gas process, liquid hydrocarbons were transformed into rich permanent gas? He did not speak only of the Young, but of carburetted water gas, and other processes where oils were retorted, as well as in the Maxim-Clark process, where they were evaporated by heat, and made a rich gas; and experiments would have to decide whether there were not as favourable conditions in these as in the oxy-oil gas process, for adding oxygen. He would be inclined, until experiment convinced him to the contrary, to look upon the Tatham process not as a competitor, but as the most valuable support for these enriching processes, and as able to raise their value up to the oxy-oil gas process. He therefore thought they must make a distinction between the Tatham process and its first successful application —the oxy-oil gas process.

Professor LEWES said he had listened with intense interest to the paper. He had a personal interest in this subject, because, early in October, he read a paper before the Society of Engineers, in which he made the statement that the illuminating value of oil gas could undoubtedly be increased to a large extent by adding oxygen to it; but he also said that, if the oxy-oil gas were used for enriching poor coal gas, they would not find that the enrichment which was produced would be greater than the enrichment produced by using oil gas alone. He now simply repeated that, because he had seen nothing whatever in Dr. Thorne's paper, or in the views which had been expressed by other gentlemen, to induce him for one moment to recede from his position. Nay, more, he could say that Dr. Thorne, who was an old scientific and personal friend of his, had carried out the bonds of friendship by proving, in his paper, the truth of the remark to a considerable extent. In the first place, there were in the paper a number of trifling points to which he could have alluded; but there would not be time for him to enter into small criticisms, so that he might as well save time by plunging into the main question. The concluding paragraph in the paper was a paragraph which he regretted more than any other. In thus bating the most important question from their point of view, Dr. Thorne made a mistake. He conceived that it was with certain other processes at present in vogue that this oxy-oil gas process must stand or fall. They had at

the present time a glut of enrichment processes. They had, for instance, a trusty friend in the Maxim-Clark process, which could be relied upon for a couple of candles when the gas contained in the holders had fallen to a low point. But the Maxim-Clark system could not compare with the oxy-oil process, or with any oil-gas process pure and simple. It was with the Young oil-gas process that the oxy-oil gas system must measure its strength. They had records of what had been done by oil gas; and turning back to a report made by Mr. Linton, the Engineer of the Leith Gas-Works—a gentleman whose utterances were quite as reliable as any they could have from other sources—they found some figures which must, however, be translated before they could see the whole force of them. Regarding the present question, Dr. Thorne's experiments (like everything else he took in hand) had been carried out in a most careful and painstaking way; and they found that for 1 per cent. of oxy-oil gas added in one case he obtained an enrichment of 0·89 candle, while in a second set of figures he had 0·81 candle. They might take the result of all the experiments, therefore, as 0·85 candle. Turning then to Mr. Linton's report upon the Young oil-gas process, they found some very interesting figures. Mr. Linton took coal gas, and mixed it with oil gas; and he found that the mixture had a candle power of 30·46. This was not an experiment made on a toy scale, but on a large scale. The original coal gas which he started with, and which was tested carefully, was of 16-candle power; so that they had there a manifest enrichment of 14·46 candles. His figures showed that he added to the coal gas 17·1 per cent. of oil gas, which gave him an enrichment of 14·46 candles. If they divided the 14·46 by 17·1, it would be found that the enrichment figure so obtained was 0·845. In another set of experiments, Mr. Linton took poorer gas. He tested it very carefully, and found the candle power was 13·67. He mixed this with oil gas as before; and the mixture was 29·69 candles. He gave the quantities in which he added the oil gas, and the volume of the mixture which he had left behind; and they found that in this case he had added 18·5 per cent. of oil gas, and for this he obtained an enrichment of 16·02 candles. If they tried this enrichment as in the other case, it would be found that 18·5 and 16·02 gave them 0·86. If they treated these figures as before, they had an enrichment for the Young process of 0·854. If this did not prove the statement he had made, that they obtained no more enrichment result by adding oxy-oil gas than by the oil gas alone, then he was not reading the figures aright. But there

they had practically identical figures for the oxy-oil gas and the Young process. He had been told that he had been using mixtures of oxygen and oil gas, and not oxy-oil gas as made by the Tatham process. All he could say was that he had been working for something like six or seven months, doing his very best to obtain good results; and they were never of the kind which would for one moment, without further proof, enable him to admit Dr. Thorne's statement that oxy-oil gas as an enricher was invaluable. What he had done was this: He took a retort, and while the oil gas was issing from its mouth, he mixed oxygen gas with it; and he obtained an increase in the illuminating value. This was done in no haphazard way. Dr. Thorne had laid enormous stress upon the mixing of the oxygen with the oil gas when it was hot; and he suggested that this had a most remarkable effect on the gas produced. He pointed out that the great stability and high illuminating power of the gas was really due to the mixing while hot. He (Professor Lewes), in his experiments, had a tube running from the retort; and he had double T-pieces at various intervals. In one he put a thermometer, with the bulb up to the point where the coal gas and the oxygen mingled. He found that, at a temperature of 80°, the oxygen and the oil gas had no action whatever on each other as they mingled together. The oxygen and the oil gas simply mixed; and the mixture made in this way gave abundant signs that there had been no combination of any kind. The experiment was made with great care. He remembered, in the course of a conversation on one occasion, Dr. Thorne told him that, when they mixed oxygen and oil gas together hot, they had a sort of semi-combination taking place between the two—some kind of semi-combination which enabled one to keep in the poor gas vapours which would otherwise condense out; and this gave an enormous value to the oxy-oil gas. He (Professor Lewes) was taken with the idea; there was something in that "premature engagement" between the oxygen and the vapours which tickled his fancy. When he got back to his laboratory, he started a set of experiments, in order to see how far this was carried out. Taking the oil gas as it issued from the retort, and mixing the oxygen at temperatures up to 80°, there was no chemical combination. He also found that, taking the mixture given up to the temperature of 80°, he could, by any of the absorbents of oxygen, get the whole of the oxygen back from the mixture; and further, by placing this heavy oil gas at the bottom of a gasholder and filling it with coal gas, he had the oxygen diffusing out of the gas, which would not have

been the case if there had been any semi-combination. He went on increasing the temperature to see if anything would take place at a higher temperature; and he then had oxides of carbon form. Directly he got up to about 120°, these commenced to collect. The oxides of carbon meant a deterioration in the quality of the gas, and also that he was throwing extra strain upon the purifiers. In this way, he came to the conclusion that this could not exist. He was very careful indeed to mix his oil gas and oxygen hot; and this was the result. He would now give one of the results which he obtained, because it was rather in favour of the process than any of his others. He took some coal gas as supplied by the South Metropolitan Gas Company, and allowed it to stand in a 400-feet holder for about a month, during which time it gradually went down until it was 11·5 candles. That holder was his store-house for poor coal gas for enrichment; and, taking a portion of it, he added to it oil gas made in this way: He put his oil-gas retort in a small furnace, and arranged the heat and flow of gas until he obtained oil gas coming off in a perfectly constant condition, so that he could rely on getting the gas of the same value every quarter or half hour. Of this oil gas, enriched with oxygen, he ran a certain proportion—10 per cent.—into an experimental holder, containing some of the 11·5-candle gas; and he found (taking care to have it thoroughly mixed, and testing it by burning every scrap of gas out of the holder, and taking the mean illuminating value as representing the value of the gas in the holder) that the 10 per cent. of oil gas had enriched the coal gas up to 16·7 candles. He then took the oil gas, issuing as it was warm, and mixed with it 15 per cent. of oxygen, and passed it into a clean holder full of the same poor coal gas, and tested it in exactly the same way; the enrichment being 16 candles as against 16·7 candles obtained by the oil gas alone. When he heard Mr. Valon's remarks, he felt there was some hope that they had obtained the key of this great secret—viz., that he (Professor Lewes) had been using, in his experiments, purified coal gas, while Mr. Herring had been putting the oxygen into his foul main; and it was the difference in the purification which was making the variation in their results. If he had used foul gas in his experiments, and then purified it, it would, he thought, perhaps have made a difference in the results; but several gentlemen who had spoken since had plucked even that crumb of comfort from him. From the experiments he had made with the greatest possible care, and which really included every suggestion that had been made to him, he was simply forced

back, by the paper read by Dr. Thorne that day, to exactly the same footing on which he stood before—that for enriching purposes they might just as well take oil gas by itself. His desire was for sincere truth. He did not wish to upset any oil-gas plant; but if he was to believe other people's experiments rather than his own, he wanted those experiments to be made manifest to his senses—he wanted to be shown those experiments, and allowed the opportunity of criticizing them step by step. The paper did not contain sufficient details to satisfy him. They had been reminded by Dr. Salomonson of Dr. Wibel's experiments, which were most admirable ones when they were made. Their friend, of course, knew that in the Bunsen burner the destruction of the luminosity was due to two causes, which were acting in certain relative quantities, and which could be perfectly well measured—these two causes being first of all the oxygen, and secondly the cooling influence of the dilution by the nitrogen. But in referring to Wibel's work, Dr. Salomonson ought also, having gone to German literature, to have mentioned the work of some more recent observers—such as Heumann. He (Professor Lewes) was sorry he had been such a "bone of contention;" but they would pardon him for saying he believed more in his own experiments than in those of other people.

Dr. THORNE said that time would only permit him to go briefly over the points which had been raised; and perhaps it would be simplest to take the speakers *seriatim*. Referring first to Mr. Valon's remarks, he thought, as he stated in his paper, the question of the using up of the oxygen was answered by adding oxygen to the unpurified gas; and Mr. Herring had referred to this point as well. In regard to this question, of course, he came to the point whether it was better to add the oxy-oil gas before or after the purifiers. His own feeling was in favour of adding it after the purifiers; but it was as well for the point to be discussed, and left to a great extent to the exigencies of particular works. Certainly, however, there was no doubt, he thought, that, if they put it in before the purifiers, they must have, with the oxy-oil gas, a larger percentage of oxygen to be taken up by the purifiers, so as to leave the oxygen of the oxy-oil gas to pass on. He had not been able to make experiments as to the character of the gas, the quantity of oxygen passed under various conditions, and so on. As they all knew, the carrying out of experiments of this kind took a long time; and when consenting to read this paper, he had hoped his experiments at Huddersfield would have occupied much less

time than they had done. In view of the difficulties of the coal strike, he had had to alter the whole system of investigation, and throw away the result of some weeks' work. Still he was convinced that the oxygen certainly would be taken out by the purifiers, unless additional oxygen were added in some way or other. Mr. Valon spoke of the effect of the addition of oxygen, and without the addition. He agreed with him as to the advantageous influence of small proportions of oxygen, even in rich gas, when added through the purifier; but he certainly thought that they must have in the purified gas, for the full advantage of the oxy-oil gas, the full proportion of oxygen that was put in with that gas. Mr. Herring mentioned that he had used oil gas alone for some time, and got into difficulties with it. He might also mention that he quoted in his paper some short series of experiments with oil gas made in the same way that he made the oxy-oil gas (excepting the oxygen, of course), and that he obtained results which were lower. In the case of oil gas, the increase of illuminating power per cent. was 0·61 candle; while with oxy-oil gas it was 0·85, or 0·89 candle—showing an increase of 33 per cent. of enriching effect, due to the addition of the oxygen. He thought that the President's remarks were answered, and referred more particularly to Mr. Herring's work, so he did not consider it needful to take up further time with regard to that. Mr. Frank Livesey spoke of the difficulty of making oxy-oil gas in addition to one's ordinary work; but he had no doubt this was a difficulty that gas managers would be very glad to get over. Other difficulties—for instance, the cost of cannel—were becoming so great that it was a case of "Hobson's choice;" and something would have to be done. If they could not use cannel, they would have to employ something else which perhaps was not quite so convenient. His experiments certainly showed that, besides the matter of cost, there was also the question of greater stability, because, although he was speaking before a rather formidable audience of gas experts, he still had little hesitation in his mind in believing that cannel enrichment was not by any means an absolutely permanent one; nor were a great many of the other enrichments that were at present used. They answered very well for their purpose up to a certain point; but there were a great many of the enrichment processes which lacked the great point of permanency. Mr. Livesey spoke of the sulphuretted hydrogen. He (Dr. Thorne) had tested the gas made from Solar Distillate and Scotch shale oil, and found it entirely free from sulphuretted hydrogen; and in that case, therefore, so far as

the question of purity went, it was as advantageous to put it into the purified gas as into the foul main. He agreed with Mr. Gandon in his statement that the essence of the oxy-oil process lay in the addition of oxygen to hydrocarbon gas—a point which was touched upon to a much greater degree by Dr. Salomonson. Mr. Tatham had always insisted that oxy-oil gas was only one of the applications of his process. There were numerous others for using the process, and he mentioned them briefly in his paper; but at present the one which had come prominently before them, and was of most general application, was the question of oil gas made from petroleums. The particular conditions existent at certain works might render it more favourable working with some of the hydrocarbon residues obtained in gas-works—that was to say, furnace oils, and so on; and this was a point which certainly deserved very much more attention than it had at present received. For the present, he had been obliged to confine his work to the one branch of the subject. Mr. Gandon had also referred to his statement that the residue was 5 per cent. of carbon. This was the fact; and he thought that, taken in conjunction with Mr. Young's statement that he obtained 25 per cent. of carbon, tended to support the results he had given, and which were confirmed by Dr. Salomonson's work—that the actual yield of oil gas, apart from the oxygen, from a ton of oil was larger when oxy-oil gas was made than when oil gas alone was produced. They had this point to consider, in addition to the actual enrichment of the oil gas. Professor Lewes quoted Mr. Linton's report, and showed figures which came very near at all events to, or about the same as, the results he had realized. Without wishing to throw any doubt on the results obtained by Mr. Linton, he, like Professor Lewes, was inclined to rely more on his own figures than on those of other people. As to Mr. Linton's work, he thought it was perhaps not so extended as was necessary. Mr. Sheard had put the results at a rather lower figure; and he noticed a few weeks ago in the *Journal of Gas Lighting* a paragraph from the Scotch Correspondent (who certainly generally looked on the bright side of Mr. Young's process), which ran: "The Musselburgh Gas Company have been working their new oil-gas plant for about a month; and Mr. W. Thomson, the Manager of the works, expresses entire satisfaction with the results he is getting. Adding one-seventh of oil gas raises the illuminating power of the gas supplied to the town by 5 candles; the quality of the gas sent out being 28 candles. The plant is on the Peebles process. Two retorts are used, which are heated, as in Galashiels,

by the same furnace as the coal retorts." That worked out at an enrichment of 5 candles for 12½ per cent. There were two points to be borne in mind: One was that the candle power of the gas to be enriched was a high one—23 candles; and, therefore, one would expect to get a lower enrichment than with a lower candle power gas. The second point was that this, of course, was working in a gas-works not under the supervision of the patentee; and they might perhaps have to discount the result to a certain extent by the working not having been carried out under the most favourable conditions. Still, as the result of running over a month, and as the figure was given and published by the Manager as being a very favourable one indeed for the process, he thought perhaps it deserved mention in that respect. With regard to Mr. Watson's remarks, he agreed that experiments of that kind were interesting; but he also agreed with the President when he said they required to be undertaken with great care, and there were a great many conditions to be taken into consideration before one could rely on any such statements. Mr. Watson had inferred that the decrease in volume was due to actual contraction in the mixture; but, seeing that he had been dealing with carburine vapour, it was much more probably due either to the deposition of some of the vapour, or the absorption of some of the vapour by water. In his (Dr. Thorne's) experiments, he certainly had not been able to detect any increase or decrease in the volume of the gas. When he had added 5 per cent. to a certain volume of gas in the holder, he had not observed an increase or decrease; but, of course, he had not carefully carried out experiments on this point. With Mr. Helps's remarks he warmly concurred. He had experienced the same sort of thing that he had spoken of—the much heavier fall in common coal gas, in keeping it in small holders over water, than would be anticipated from the general statements of working results of gas managers; and he had also experienced a greater advantage in adding oxy-oil gas to enrich coal gas which had been allowed to lose its enrichment in the holder, than freshly-made coal gas that had not been enriched. With regard to what Dr. Salomonson had said, he thought his results and the way he had tabulated them—comparing the results with oxy-oil gas and oil gas—were of great interest; and, of course, they corresponded almost exactly with the results which he (Dr. Thorne) had been able to lay before the members, but they were expressed in a different way. He was quite prepared to admit that there were many other ways of looking at the Tatham process than as the oxy-oil gas process; and he thought

it was more than probable that the addition of oxygen under certain conditions ought be of advantage in several other processes. Coming now to perhaps the stronger criticism of his friend Professor Lewes, he found it much more difficult to deal with the matter—their results being so diametrically opposed; and he did not know how they really were to explain the question. Professor Lewes said he relied on his results; he (Dr. Thorne) ventured to do the same. In his own case, the experiments had been carried on in several places, and under various conditions, both on a small scale and on a large scale; and he would admit that he had been forced from, in the first place, a sceptical turn of mind to the reverse—to a thorough belief in the process, in what the patentee claimed for the process, and in not only what he claimed, but in the value of the process as being in advance of all other systems at present on the market. The process must, of course, stand or fall by comparison with the best system. He was quite prepared to admit, with Professor Lewes, that the Young process was the one they had to look upon as the—well, let him say for the moment competitor with the Tatham process; but he thought that very possibly even the Young process might find the Tatham process to be a friend rather than an enemy. His own results certainly led him to believe, in the present state of things, that enrichment by the Tatham process was decidedly cheaper than by the Young system. He still could not quite understand Professor Lewes's statement, even after his own admission, that oxygen was detrimental to the effect of oil-gas enrichment.

Professor LEWES: I said it did not do it any good.

Dr. THORNE (continuing) said that, in the paper recently read at the meeting of the Society of Engineers, Profesor Lewes said: "Such a gas would be useless for enriching purposes, as the oxygen which, with the rich gas, perfected the burner, and so gave an increase of illuminating value, would, when the gas came to be diluted with poor coal gas, overdo the combustion, and would cause a loss rather than a gain in illuminating value." Certainly until further experimental evidence was brought forward, he should stand to his own figures. They also obtained an increased volume of oil gas produced in the process of making oxy-oil gas over other processes of making oil gas. This point was difficult to explain; but he believed it was due to the fact (and this belief was increased by the fact that they had obtained a much less percentage of coke than the Young people, for instance) that the hydrocarbons did not undergo such apid cracking. In the Young process, they got from the

oil a mixture of gas and vapours, which was very carefully washed; and this washing took out not only the vapours that would be taken out by condensation, but others which would be deposited slowly in the course of the mains, and so on. These condensed vapours were taken back into the retorts. Some were re-vaporized, and others were cracked over and over again; in each cracking losing a part of the hydrocarbon in denser forms, which did not crack so readily afterwards. In the case of the oxy-oil gas, he believed some of these less easily condensable vapours (or the substance lying between vapours and gas, because there was no line of demarcation) were carried on; and in this way they had less repeated cracking, with the decomposition of the oil, so they obtained more of the carbon and hydrogen of the oil in the form of oil gas than in ordinary gas processes. Professor Lewes had spoken of their conversation with regard to the combination or, as he called it, "engagement" of the oxygen and oil gas. He (Dr. Thorne) was still of the same opinion; and he believed that they had a gas which, in some way or other not well understood, exerted, as it were, some sort of solvent action. His experiments on oxy-oil gas had led him also to believe in the increased stability given to the gas by the oxygen; and this view was most strongly increased by repeated experiments carried out by himself, by those of Mr. Herring, and by the statement made by Dr. Salomonson. As to the point that the oxy-oil gas, when subjected to severe conditions, actually lost less candle power than the unenriched gas, he himself did not see how they were to explain the fact that 15-candle gas would lose 1½ candles if kept for a definite time under certain conditions, and when the same gas was enriched with (say) 10 per cent. of oxy-oil gas it would lose only 0·5 candle under like conditions, except upon the assumption that the oxygen had some special and peculiar carrying or solvent power over the hydrocarbons. They had now come to a point when their experiments seemed, at all events at the present, to be diametrically opposed. Professor Lewes had said he would like to verify the experiments; and he thought that Mr. Herring would be very pleased to see him, and give him facilities for carrying out the experiments. The remainder of the plant at Huddersfield was now in forward progress; and, before long, the whole of it would be in thoroughly good working condition, when he hoped experiments would be made on a large scale. All he could say at present was that he was prepared to stand completely by the results he had put forward; and he held absolutely to the view

he had already expressed, that the oxy-oil gas process was a great advance on any of the other systems at present available.

The PRESIDENT, in proposing a hearty vote of thanks to Dr. Thorne for his valuable paper, said his only disappointment with regard to it was that it did not wear a little more scientific aspect. They had had this put so strongly before them—the differences in the two methods of using oxygen, in the one case mixing it with the oil gas, and in the other making it part and parcel of the process of making the gas—that it would have been interesting to have had some specific explanation as to how these differences came about.

Mr. C. E. BOTLEY (Hastings) seconded the motion, which was agreed to.

Dr. THORNE briefly acknowledged the compliment.

This concluded the business before the meeting; and afterwards high-tea was served.

MANCHESTER INSTITUTION.

QUARTERLY MEETING, NOV. 25.

This Meeting was held at the Palatine Hotel, Manchester—the chair being occupied by Mr. JAMES BRADDOCK, of Radcliffe, Senior Vice-President, in place of the President (Mr. W. R. Chester, of Nottingham), who was prevented by illness from attending.

THE MINUTES.

The HON. SECRETARY (Mr. S. S. Mellor, of Northwich) read the minutes of the previous meeting; and they were confirmed.

ELECTION OF PRESIDENT.

Mr. JAMES PARKINSON (Brighouse) then proposed the election of Mr. Braddock to the office of President.

Mr. T. DUXBURY (Darwen) seconded the proposition; and it was carried by acclamation.

Mr. BRADDOCK having briefly returned thanks,

Mr. J. CHADWICK (Oldham) read the following paper:—

THE STACKING OF COAL, AND COAL-HAULAGE MACHINERY.

As time goes on, and members of Gas Associations continue to meet with increasing frequency, it becomes more difficult for those at the head of the various organizations to find new subjects to bring before the members for consideration, discussion, and interchange of opinions. But it is not at all times necessary that we should have new subjects to confer upon, when we meet together to compare notes. Many old subjects we may revive, and look at them (it may be) from different points of view—approach them with a wider experience, a more extended acquaintance, and possibly with our knowledge more developed. Of the many subjects which have been brought before Gas Associations at various times, and which have been carefully considered from various points of view, the "storeage of coal" has not by any means been neglected. Many gentlemen have, on different occasions, brought this subject before the various Associations with which they were connected; and it has been freely discussed. One of our own respected Past

Presidents gave us a most valuable paper some time ago upon a somewhat similar question. It is not, therefore, that I have any intention, or am even capable, of introducing anything new on this subject that I have undertaken to bring it under your notice, but circumstances have recently occurred which caused me to think that it would not be an inopportune time to talk over this old subject once again.

It seems to me that the stacking of coal is, in future, likely to receive more consideration at the hands of large users of this commodity than has perhaps hitherto been the case. True, the importance of holding coal in readiness for cases of emergency by large consumers has not been neglected in the past; but what has been considered a sufficient quantity to hold for the temporary suspension of supply, may not be considered adequate in the future. I need not go into the question as to the quantity of coal such industries as are represented by the iron trade, or the railway companies or steamship companies, or the many other branches of industry which are dependent upon coal amongst other things to work their various concerns, their traffic, &c., should hold. Sufficient for present purposes to confine our consideration to what most particularly concerns our own industry—viz., the gas-works of the country. I think I may safely say that it has been generally, if not universally allowed, that it is desirable (nay, even necessary) to have on our works a stock of coal at all times, to prevent serious inconvenience in case of any stoppage of supply. The quantity necessary to be held as a safeguard may have varied in the opinions of different people; and the geographical position of the particular works may have had some influence in determining what was a safe quantity to have.

The stacking of coal in most cases costs money; and the less we have need to stack, to be on the safe side, may be the most economical. A quantity equal to six weeks' maximum consumption has been generally considered sufficient to have in stock at any time; and naturally those who have adopted something like this quantity would possess this stock at the commencement of the darker weather—say, in autumn. Most of us who have been fortunate enough to have so large a quantity of fuel by us at that time, have entered upon the time of heavier make of gas with complacency and composure, so far as the coal supply was concerned—thinking we should be able to meet all requirements; and generally we have been able to do so. But whether we shall consider such a quantity sufficient, or whether we shall place much reliance on our geographical

position in the future, are matters which may be open to consideration and question. I am of opinion that many of us will take means to provide for the storing of coal in larger quantities than we have hitherto done. The stoppage of the coal supply from so large a portion of our coal-fields, and the suspension of work extending for so long a time as has been the case quite recently, may well cause us to consider the advisability of holding larger stocks at our gas-works.

Unfortunately, the relations between capital and labour in almost all industries are such that a cessation of work may be brought about upon large or small differences of opinion or action from either side. The recent stoppage of work in the coal trade shows us, among other things, the extreme difficulty of obtaining proper supplies of fuel under such circumstances. Although large stocks were held by many colliery proprietors, still there was great difficulty in moving them away. It may be said (indeed, it has been said) that if there had been no large stocks, there would have been no stoppage. That might have been the case; and it is not improbable that colliery proprietors will be unable in the future to accumulate such large stocks on their pit-banks. But if the stocks are small, who shall say that a stoppage may not even then take place, or an advance in the price of coal be made to ensure the pits working. Capital insisting on a reduction of wages to labour, was the cause of the recent stoppage. The converse is just as likely to occur. Labour may insist on a greater share of proceeds than capital is disposed (or even able), for the time being, to grant, with similar results. From whatever cause the stoppage of the coal supply over a large area or for a lengthened period is brought about, besides the difficulties experienced in obtaining supplies, the result is a great advance in the price of the material. This was so in a marked degree quite recently; so much so that it is probable that many gas authorities will be obliged to advance the price of gas to their consumers, in order to recoup themselves for the extra expenditure thereon. It is hardly likely that disputes in the coal trade of such an extensive character will occur very frequently; but still disputes have occurred, and will occur, at intervals. Can we not then mitigate the evils, and lessen the difficulties somewhat when a suspension of supply does occur, by holding larger stocks of coal than we have hitherto been in the habit of doing?

The saving of labour in every branch of industry has for many years past been the aim of mechanicians, as well as of those persons connected with, and in charge of, our various factories

and workshops. A large quantity of work which to-day is done quickly, efficiently, and economically by the aid of machinery, was formerly accomplished by hand labour only—necessitating an expenditure of more time and more money. No matter where we go, or where we turn in our busy hives of industry, labour-saving appliances meet us on every hand. The mechanical engineer makes special tools for various kinds of work required in his own business; the carpenter has his machines for planing, mitring, squaring, boring, &c.; the stonemason has the bulk of his rough and heavy work done by machinery; the textile industry has its many improvements in machinery for expediting the work performed; the bookbinder, the shoemaker, the tailor, and I might enumerate a great number of other trades whose work has been expedited and probably made more efficient and economical by the aid and use of machinery. It is not, therefore, surprising to find that the use of machinery in our gas-works is extending. It may be said that its adoption has not been so general or so quick as it ought to have been. Still for many years the adoption of machinery has been the idea and aim of many people; and trials of various kinds of apparatus for working our retorts have been conducted. Some have been fairly successful, and have been continued; others have shown room for improvement, and have been modified and amended. Considering that machinery for this purpose has to undergo great hardship in its use—embracing very rough handling and usage, great variations in temperature, and that it has to work in an atmosphere (more or less) of dust, dirt, and smoke—I think we must allow that the retort-stoking machinery of to-day has made considerable headway towards general favour and more extended adoption.

For the handling of coal and coke, the use of machinery is becoming a matter not only for consideration, but one that is being acted upon. The stacking of coal, for instance, may become a serious item (as to cost) in many gas-works. When thousands of tons of material have to be put into our sheds every year, it becomes not only a question as to which is the cheapest way, but many times also which is the most expeditious. Gas-works are differently situated, and exist under quite different conditions and circumstances in having to deal with their coal traffic. Some works have neither railway nor canal accommodation; and all their coal has to be carted into the works. Others have proper railway sidings on the works. Some are in connection with canals or with navigable rivers; but these will have the coal to move from the railway trucks or

barges, as the case may be. The situation of the works, and the quantity of material to be dealt with, will have to be the factors which must help us to decide on the best and cheapest means of transferring the coal from the barges or trucks to the coal-stores. If the works are small, and the quantity of material consequently not very large, hand labour may still be the best and cheapest means; but when there is so much material to move that it is possible to reduce the amount paid for hand labour by what will cover the interest on the cost of machinery, together with the wear and tear thereof, so soon I think it is advisable to consider what kind of machinery will best suit the particular requirements, and to arrange and adopt accordingly.

A jib crane might be found sufficient in some cases; and it might be supplemented by the use of small tip-waggons on an elevated roadway. Conveyors might perhaps come in to be useful and efficient. Elevators and conveyors combined might still better meet particular requirements; or other means might be devised to suit the particular place to be dealt with.

I now purpose giving you a description of the coal-haulage machinery I have erected at one of the works under my charge. At the works to which I refer, and which are known as the Higginshaw works, belonging to the Oldham Corporation, there is a branch railway running alongside the land; but it is some 21 feet below the level of the coal-shed. By a series of inclines, we get the coal-trucks on to the same level as the shed-floor, and alongside one end of it. Formerly, the unloading of coal cost us about 4d. per ton, by hand labour. Some four years ago, after carefully considering several methods for adapting machinery, I eventually came to the conclusion to adopt a system which would combine the breaking, elevating, and conveying of the coal, so that I might be able to deposit it in any part of the shed.

I have two sets of breakers, elevators, and conveyors, each a duplicate of the other; but they are separate and distinct, and complete in themselves, with the exception that the steam for working them is generated in one boiler. I shall describe one set of machinery, and the working thereof: A 10-horse power horizontal steam-engine, running at about a hundred revolutions per minute, works the apparatus. The engine is geared to the coal-breaker by steel wheels of double purchase. The breaker is composed of two cast-steel rollers, with gripping teeth. Small coal passes between the rollers; while the teeth take hold of large lumps and break them. The elevator is fixed conveniently to take the coal from below the breaker to a

sufficient elevation to carry it along the coal-store. The hoisting apparatus is made for lifting a railway truck, so that its contents may be emptied into a hopper immediately over the breaker. This hopper is capable of holding about 10 tons of coal. The hoisting gear is also arranged so that it may traverse along iron girders; and it is able to take hold of a waggon at either end. The conveyor is a band-conveyor, composed of a number of thicknesses of cotton cloth stitched together lengthwise. It reaches from the top of the elevator, where there is a shoot to allow the buckets to empty themselves on to the conveyor; and the band reaches from one end of the shed to the other—a distance of some 200 feet—and travels about 190 feet per minute. A series of rollers carry the band and coal upon it; and the empty or return band is carried by another set of rollers. The band varies a little in length, according to the state of the weather and other circumstances; but an arrangement is made by which any variation can be taken up or given out as the case may be. There is also a throw-off carriage, which can be placed in any part of the shed, and which will then throw the coal off the band at that particular spot. At a convenient place, a shaft is fixed to work in bearings attached to wall brackets; and on this shaft there is a pulley which carries the main driving-belt from the engine. There are also pulleys to work the waggon hoisting and traversing gear, with open and crossed belts for working in different directions. These belts are controlled by strap-guiders, worked by chains, and are under easy control of the workmen. The elevator is worked by a sprocket-wheel fixed on this shaft, and a pitch-chain passing over another sprocket-wheel at the head of the elevator. Sprocket-wheels and chain also work the conveyor.

In working, the railway trucks are brought over the hopper; and the truck is then taken hold of by the hoisting gear, and one end lifted. The door being opened at the other end, the coal falls into the hopper, and through the breaker into the pit at the bottom. The elevator buckets are working through this pit, and scoop up the coal, and raise it to the head of the elevator, where it is thrown into the shoot, guided to the conveyor, and taken to any part of the shed required.

We have had this machine working for more than three years; and I am pleased to say it has worked exceedingly well.

I think that this was about one of the first installations of machinery for the specific purpose of unloading and stacking coal; and the amount spent in repairs and maintenance up to now has been practically *nil*. The wear and tear is not

nearly so much as I anticipated. We find a monetary saving by its use; and this saving will be greater as more material is required, because the machinery is capable of doing three or four times the work we have at present for it to do.

The total expenditure on the machinery, and for alterations incidental to its erection, was £3700. The amount of money spent in wages last year for unloading 34,000 tons of coal was £330 less than the actual sum spent on a similar quantity of material previous to the erection of the machinery. If we reckon 3½ per cent. interest on the outlay, and 2½ per cent. for wear and tear, we have a charge of £213, which leaves us a saving of £117 per annum. But we might reckon 5 per cent. for wear and tear, which, with the charge for interest as before, would make a sum of £305—still leaving £25 to the good. But, as I have already said, we have expended very little on repairs yet; and I think that the 2½ per cent. will cover everything in the shape of wear and tear that will be required. The expenditure on coal, coke, water, and oil to work the apparatus comes to about 10s. per week.

We also find it most convenient and expeditious in its working. Most of you are aware that traffic does not always come along very regularly. In the winter months for instance, when foggy weather prevails, it often happens that traffic is detained; and then when the weather clears somewhat, a sudden inrush of waggons comes—occasionally two or three days' traffic all at once. We can deal with this without much inconvenience. We have on many occasions taken such a quantity of material in one day, with very little extra trouble.

In the arrangement of the machinery I have been describing, the movement of the coal is all in one direction. But this can be altered, and arranged to suit any particular requirement.

Many gentlemen connected with gas-works in various parts of the country have been to see this machinery working. Some are members of this Institution, and they may perhaps give us their impressions thereon. I understand that some were so well satisfied with their visit, that they are contemplating erecting machinery of a somewhat similar character. Among others, I may mention the neighbouring town of Bury, where the Gas Committee, after very careful consideration, and under the recommendation of their Manager, have decided to erect, and have now in hand, an installation of coal-haulage machinery on similar lines, and for a like purpose—viz., stacking coal in their shed. I hope they will find as much benefit from its application as I have from the one I have been describing to you.

By the kind permission of Mr. John West, one of our members, I am able to show you a few drawings where this system is made to suit various requirements.

The Plymouth Gas Company are about to erect at their works a plant by which they anticipate being able to dispense with a considerable amount of labour in transferring coal from ships to their store. The Gaslight and Coke Company also have had machinery for coal-haulage erected at their Kensal Green works, and, so far as I can learn, with satisfactory results. This conveyor, however, is somewhat different in construction to the one I have been describing. I think therefore we may conclude that coal-haulage machinery in gas-works is on the increase; and ere long we may hope to have other information which will help us towards a more general knowledge as to the economics thereof.

Before I close my paper, I may perhaps say one or two words about the application of machinery for the haulage of coke. This also is receiving great attention at the hands of gas managers; and coke-conveying plant has already been erected at several gas-works—Birmingham, South Metropolitan, and Melbourne, being amongst the number. For moving coke, I think machinery will become more extensively used, because it not unfrequently happens that coke has to be piled up to a great height, and this becomes a matter of considerable expense. With the machinery, however, as now made, coke as it leaves the retort-house can be taken into store to any reasonable elevation, or it can be deposited into hoppers ready for immediate delivery into carts, barges, or trucks, as the case may be. I believe our President (Mr. Chester) contemplates the erection of coke-conveying plant, with breaking and washing apparatus combined, by which means he will be able to prepare his coke to suit the special requirements of his district.

I have here a drawing showing an arrangement for coke conveying, elevating, stacking, screening, and filling into waggons or sacks. The coke, as it is drawn from the retorts, falls on to conveyors, which carry it to a pit, about the centre of the retort-house. This is a metallic conveyor, formed of iron or steel plates; and the hot coke, on its way to the pit, is quenched with water. From the pit, it is elevated and then conveyed into the yard for storeage, or placed into hoppers or railway trucks, or conveyed into screens, which clean and sort it to various sizes, when it may be put into sacks ready for sale.

The introduction of inclined retorts has brought coal elevators and conveyors more into use; and this system of carbonization

seems to lend itself readily thereto. Many places where this system is working have some kind of coal-haulage machinery in connection therewith.

Well, gentlemen, I think you will agree with me that there are sufficient examples of machinery at work for transporting materials in our gas-works to warrant us in saying that it has passed beyond the experimental stage.

Discussion.

Mr. J. CHEW (Blackpool) said he had had some little experience of machinery in gas-works; for he had all the machinery which he could possibly adopt in use at his works, where he had to deal with 25,000 tons of coal per annum. As the members all knew, the cost of dealing with a ton of coal, from the time it was deposited in the store until the gas entered the purifiers, was something like 3s. per ton; and it was with this item that they had to deal when they were considering the question of effecting a saving. Most of the improvements introduced by gas managers of late years had been for the benefit of the men; the workmen had reaped all the advantage in being able to do their work with more ease and comfort. The introduction of charging and drawing machinery had certainly had this result; and if this machinery was not so perfect as they would like it to be, it had certainly made the men's work easier. It was the bugbear of the gas manager's life that, before he could consider any improvement, he had to be sure of the way in which the workmen would receive it; for some of them were not content even with eight hours a day and the easier labour of modern works. However, if they could lessen the demands of labour by the introduction of machinery, they would relieve themselves of the bugbear of their lives. Those who had had experience of generator furnaces knew that their introduction had done away with drunken week-end shifts; and that the cooling of retorts was not now so common as it used to be. This was a step forward; and it took a certain amount of trouble off a gas manager's shoulders. Turning to the subject of stacking coal, Mr. Chew said his opinion was that fresh-got coal made the most gas, and of the best quality. In making their contracts at Blackpool, they stipulated for fresh-got coal; and they did not want to stock more coal than was required for times when deliveries could not be depended upon. Fresh-wrought coal was certainly worth from 6d. to 1s. per ton more than coal that had been stacked; and this fact must be taken into consideration. At the commencement of the recent strike, he (Mr. Chew) had

in stock only one month's supply of coal; and since then he had had to buy 8000 tons at the higher prices. None of them, he supposed, anticipated that the strike would last sixteen weeks. For the haulage of coal, he thought the method described was the best that could be arranged. Different works would, of course, vary in their needs; but wherever machinery could be used, it should be used—for there was no comparison in regard to cheapness between hand labour and machinery. In these days, money was exceedingly cheap. Promoters of electric light schemes could raise capital on terms of repayment in thirty years; and he presumed it could be obtained for gas undertakings on the same conditions—in other words, it would not cost more than about 4½ per cent. If this was really so, they ought to seriously consider how much machinery they could utilize. Mr. Chadwick had told them that he dealt with 34,000 tons of coal a year; and that the machinery for the purpose cost £3000. This was certainly not a large sum; and the point was important, because, as they knew, many gas-works were over-weighted with capital; and every addition to it had to be very carefully considered. Still, machinery was better than the unmanageable labour with which they had to deal; and he (Mr. Chew) advocated it on the ground of economy, and because it did its work better and with less trouble. The only fault he could find with the system Mr. Chadwick had described, was that the coal had to be put below the ground-level, and then lifted up. This seemed to him to be a mistake, and a waste of energy. Nor did he believe in breaking coal, as was done by this machinery. Experience taught him that, if coal was broken too small, a considerable amount of trouble was caused afterwards by the fine dust produced being drawn direct into the ascension-pipes.

Mr. T. B. BALL: You get too much vacuum.

Mr. CHEW said they all wanted to get the largest quantity of gas from the smallest bulk of coal; and breaking the coal was a great mistake, for it increased the amount of dust, and was an obstacle to the introduction of machinery. At his works, he had one retort-house served by machinery, the charging power of which was capable of improvement; but the drawing part was excellent. He also used steam for moving the coal-waggons, without the intervention of a locomotive engine; and in his case, if the coal was to be stacked, it was put down at a lower level, while if it had to be lifted it was done by an elevator. The elevator was an excellent machine, though it wanted pretty close watching to make it pay. It was necessary to have

duplicates of these machines, and to have them well cared for. The tendency to breakdown was in the accumulation of dust and water in the pit below the hopper.

Mr. ISAAC CARR (Widnes) remarked that Mr. Chadwick had brought this paper forward at a very opportune time. No doubt if they had known how long the recent colliers' strike was going to last, they would all have had much more coal in stock than they had when it began; and the subject of stocking coal was, therefore, one which was largely in all their thoughts. Since he came into Manchester that afternoon, he had met a gentleman who had sufficient foresight—though he was in the midst of a colliery district—to put into stock, before the strike began, three months' supply of coal. Unfortunately, he (Mr. Carr) had only six weeks' supply; and he at first felt pretty confident that with this he should see the whole thing through. No doubt the prolongation of the strike over so extended a period would make them all do something in future to provide against a similar difficulty. The arrangement which Mr. Chadwick had described seemed to be an excellent one of its kind, and to have numerous points of advantage. The mechanical arrangements appeared to be very clever. Mr. Chadwick remarked, however, that the geographical situation had a good deal to do with the adoption or otherwise of machinery of this kind; and he (Mr. Carr) did not see the advantage of this arrangement over the Beckton system—one which had been adopted in many Lancashire works. If they had the coal-store low enough, and the railway high enough, with the line of rails passing the whole length of the retort-house, this system was excellent. On the other hand, if the works were so situated that a line along the end of the retort-house only was possible, the arrangement described by Mr. Chadwick would be of advantage. He (Mr. Carr) failed, however, to see where there was gain—in fact, he should think Mr. Chadwick's arrangement was more costly than the Beckton system. As he understood from the description, the motion of the belt described in the paper was longitudinal only. The angle of repose of slack was about 45°; and so, unless there was a lateral motion of the belt, it seemed to him that the stack of coal in the retort-house would require a great deal of manual trimming.

A MEMBER remarked that it would be just the same with an overhead railway.

Mr. CARR said that was just the point which he was trying to get at; for he did not see the advantage which this arrangement possessed over an overhead railway. The coal would not

fill up from the railway without manual trimming; and he thought the same objection would obtain in regard to this travelling belt. An important point was, How much did it cost to stack the coal before the introduction of the machinery? If works were in a bad situation, and it was very costly to get coals into the place, and a system of this kind would take 3d. or 6d. a ton off the cost, this would be sufficient to recommend its adoption. As Mr. Chew pointed out, money was now very cheap; and if, by the introduction of machinery, they could save a few pence per ton of coal, it would be a great advantage.

Mr. G. E. SAVILLE (Todmorden) asked if the author of the paper did not find that the quality of the coal which had been broken deteriorated faster than that which was unbroken.

Mr. A. SHIRES (Kidsgrove) was astonished to hear from Mr. Chew that the loss by stacking coal was from 6d. to 1s. per ton. As to the breaking of coal, he certainly did not see the advantage of it; for it would be better to buy nuts at a lower price, than buy round coal and then have to break it.

Mr. S. GLOVER (St. Helens) said he had had similar experience to that of Mr. Chadwick with regard to haulage machinery; and he could see an advantage in an arrangement of this sort, notwithstanding the loss which took place from the stacking of coal. As to Mr. Shires's objection, all that could be said was that they were not all able to buy nuts; and if they were going to use machinery of this kind, it was much better that the coal should be broken than that it should be dealt with as it came from the pits. For stacking coal in small works, he recommended a jib-crane. He put down some coal in stock in the yard at the St. Helens Gas-Works; and he found a jib-crane very useful in picking it up again, and removing it to the retort-house. It seemed to him that they were coming to a time when it would be desirable to have machinery not only to put coal into, but also to take it out of stock. In Mr. Chadwick's case, the belt returned immediately underneath that portion which was carrying the coal; but it seemed to him (Mr. Glover) that much would be gained if the belt could be so extended as to return by a subway under the floor of the retort-house, with suitable openings at intervals, so that the coal could be carried by this means from the store to the elevators of the charging machinery, and so tipped into the fixed hoppers. He was surprised to hear that the whole expense of this apparatus —especially when he found that it was in duplicate, and that alterations had to be made in the yard and in the drains and so on—was only £3700. The cost was very low indeed. With

regard to the difficulties of charging by machinery, to which Mr. Chew had referred, he could only say that he had experienced no trouble whatever; and he should certainly not like to feel that he was not safe unless he duplicated the machinery. It was true, the cost was only £2000; but he did not want to spend a similar amount in that direction at present. If he were going to erect a new retort-house, he should sink the coal-store very much deeper than hitherto. He had no objection to putting the coal into a hole for the purpose of getting it out again, if he could thereby gain an increase of storeage-room; for there was no difficulty in lowering the elevator to any reasonable depth. For the haulage of coke, the arrangement which had been described by Mr. Chadwick seemed admirable.

Mr. CHEW asked if Mr. Glover had never had a breakdown of the strap, nor a choking of the elevator-pit.

Mr. GLOVER thought he had never had the elevator strap broken; and his was not one of the most modern arrangements. His practice was to have the pit at the bottom of the crusher cleaned out every week; so that there was never any accumulation of coal or coal dust to choke up the machinery. His experience was that the cost of repairs was very small indeed.

Mr. W. W. HUTCHINSON (Barnsley) remarked that the subject of the stacking of coal was one of much importance. They were advised by Mr. C. E. Jones, of Chesterfield, a few years ago to stack coal more extensively; and he (Mr. Hutchinson) had had some experience in this direction, though not with the use of machinery. His experience was that the best course was to stack coal of a suitable character, and hold it as a reserve for such an emergency as they had recently had, rather than to use from the older store, and put the new arrivals into stock. After the first twelve months, the depreciation of the value of coal in stock went on very slowly indeed. He had had a heap of 2000 to 3000 tons of coal stacked in the open to a depth, in some places, of 12 feet or 14 feet. Roughly speaking, the depreciation in two years was rather more than 10 per cent.; he was somewhat surprised to find it was so little. A stack of coal was preserved from the influence of the weather by covering it with a layer of pea-nuts, which would absorb the moisture when it rained, and give it out again when the sun shone, and so prevent it penetrating to the bulk of the coal underneath. Gas engineers would in the future have to stock coal in much larger proportions than they had been accustomed to do hitherto. In his opinion, wages disputes in the coal trade were largely the result of the constant fluctuations in the price

of iron. The tables which were published with regard to the output of coal, and its use for various purposes, showed that the coal used for iron production was a variable quantity. For gas-making purposes, the quantity of coal required was in a gradually ascending ratio; and the fact was the same with reference to the domestic consumption. Just now, there was a movement in the direction of building more battleships, which would mean a larger demand for iron and a consequent stiffening in the price of coal. From the spirit abroad in Barnsley and its neighbourhood, he felt sure that the miners would not accept any reduction of wages if they could possibly (by strike or otherwise) avoid it; and his opinion was that gas-works should stock coal if the material could be had at a reasonable price. Most of them ought to have five months' supply. At the Barnsley Gas-Works, they provided a three months' supply. Three months' stock of coal did not mean three months' supply, for they could not afford to run quite dry at a gas-works, and leave the neighbourhood in peril; so that three months' supply of coal really meant well on towards five months' stock.

Mr. CARR: Do you mean on the maximum or the minimum consumption? Would you say five summer or five winter months?

Mr. HUTCHINSON: I do not mean five months of winter.

Mr. CHEW: Do you mean that we should have three months' supply at Christmas?

Mr. HUTCHINSON said he thought they ought to have all they could possibly get. Some coalowners had expressed surprise that gas managers had been able to keep up the supply as they had done without having recourse to such large coal-fields as those of Yorkshire. This showed that, if the managers had possessed such large supplies as he had spoken of, things would have been very different. The miners really meant to leave everybody without coal; and they nearly succeeded in their object. In future, gas managers would not be able to depend upon coalowners stacking coal, because when they did so, and trouble occurred with the men, there was difficulty in getting it away. A miner who had coal in his cellar would be very much aggrieved if anybody wanted to prevent him from fetching it out. But miners did not hesitate to prevent coal from being removed from the pit bank; and coalowners who had kept up prices at the request of the men, and had had to stock their coal in consequence, had been the chief sufferers from this policy. One of the arguments of the miners was that gas companies and corporations should be made to pay more

for their coal. He took it that the owners of gas-works were really the friends of the miners; and it was news to him that those who were considerable consumers of an article should be branded as the enemies of those engaged in its manufacture. They had certainly been compelled to buy coal at a very high rate at times; and they ought to have the advantage when it was cheap.

Mr. T. B. BALL (Rochdale), referring to the machine described by Mr. Chadwick, said he was rather surprised to hear that the belt was composed of cotton cloth stitched together. He supposed it was rather stiff cloth. He should also like some information as to the means by which the coal was kept on the conveyor until it reached the point at which it was turned off. Mr. Glover had referred to the question of taking coal out of stock again. He (Mr. Ball) believed this had been done by The Gaslight and Coke Company at their Kensal Green station. He was very much interested in their design for handling coke; and he should like to see it in operation. The difficulty of dealing with hot coke seemed to him insuperable. He knew one place where it had been attempted; but the attempt ended in dismal failure. For the first two or three days, it promised to be quite successful. The water and the hot coke, however, heated the trays, and turned them up into all sorts of shapes; and it became quite impracticable to make them work. Mr. Chadwick said that the handling of his coal cost him 4d. per ton; also that the whole expense of his conveyor amounted to £3700, and that if 5 per cent. depreciation and 3½ per cent. interest were allowed, it left a balance of £25 to the good. He (Mr. Ball) did not think this was such a saving as would secure the adoption of the machinery in many works. Practically, they would be just where they started after getting this installation put in, with the advantage that they could deal more quickly with the material. So far as pounds, shillings, and pence were concerned, they would have no gain, or hardly any worth mentioning, because he did not think 5 per cent. was too much to allow for depreciation; and if, in dealing with 35,000 tons of coal, they could only save £25, some of them would have difficulty in persuading their directors and committees to expend £3000 or £4000 on the machinery. In most gas-works, however, it would cost more than 4d. per ton to put the coal into the store. There was, of course, the advantage which Mr. Chadwick had mentioned, that they could deal with a large quantity of coal in a small space of time, without having the trouble and inconvenience of increasing the staff at short notice. But, on the

other hand, something might go wrong with the machinery; and then the whole thing would be at a standstill.

Mr. R. PORTER (Elland) remarked that he had had some experience of machinery for handling coal; and the paper had therefore been extremely interesting to him. Mr. Chadwick had referred to the tipping of waggons of coal, 10 tons at once, into the hopper of the elevator. How did he get over the difficulty of having the elevator choked? for if he tipped a waggon load of soft pit coal on to the breaker at once, he (Mr. Porter) did not see how the machine was going to deal with it. He did not see the advantage of breaking coal and then storing it for a long time. Why should it not be handled and stored in the way in which it came from the pits? Another question that he should like to ask was as to the width of the band of the conveyor. Mr. Ball had referred to the question of cost; and certainly the saving, which seemed to be about 0·82d. per ton, was very small on the large quantity of coal Mr. Chadwick had to handle. At Elland, the gas-works were in close proximity to both the railway and the canal. They approached the Railway Company with regard to better facilities for receiving the coal, and were told that, if they were prepared to lay out £3000 on a siding, the Company's engineers would consider the matter, and report upon it. As they had only about 8000 tons of coal to handle every year, they were not prepared to spend so large a sum; and therefore they had to consider other means of overcoming their difficulty. One question was whether they should deepen or lengthen the coal-store. If it were lengthened, the cost of bringing the coal back to the retorts would be greater; while if it were deepened, it would be impossible to get the coal out by hand. He decided upon the latter course, and fixed up an elevator. The coal came by canal, between which and the coal-store there was a towing-path. They had consequently to have a moveable elevator over a width of 14 feet; and it had also to accommodate itself to the rise and fall of the boat, which was 4 feet. The hopper was filled by hand; and the coal was conveyed on a band across the towing-path, and then delivered into another hopper, and so on to a second band, which ran at right angles with the building. The appliance was constructed to deliver at the rate of 20 tons per hour. It did not enable them to dispense with manual labour; but it rendered them independent of outside labour.

Mr. C. WOOD (Bradford), referring to the subject of the deterioration of coal in stock, said he thought a great deal more had been made of this than was warranted by the facts. He

had carried out some experiments with Yorkshire coal which was stocked in 1888. In the first two years, there was slight deterioration—amounting, perhaps, to 10 per cent.; but after that, if it was hard coal, there was not much. If coal was stored under cover, there was very little indeed. It seemed to him to be a mistake to break coal before stacking, for small coal deteriorated more rapidly than unbroken coal. They were all, no doubt, agreed that in large works it was economical to have machinery for dealing with the coal. That which was stacked was perhaps only 15 or 20 per cent. of the total consumption; and the interest and depreciation would, he thought, go a long way towards making up the expenses of working. Something had been said about the trouble which elevators for dealing with coal might cause. At Bradford they had had experience with machinery of this kind for the last three or four years; and he could not recollect any instance in which great difficulty had arisen. They had not had a single belt broken. As to Mr. Hutchinson's suggestion that they should store five months' supply of coal, in the case of Bradford it would amount to something like 50,000 tons stacked up; and the interest upon this would be a rather serious item. Personally, he was most interested in what Mr. Chadwick had said as to coke-conveying machinery. The greatest trouble they had with machine stoking was that of dealing with the coke afterwards.

Mr. J. West (Manchester) remarked that in the Manchester district it was not customary for gas-works to have such large stocks of coal as they did in the South of England; but his opinion was that it was desirable to have them, in order that they might be protected against strikes. In the South, where they depended upon supplies of seaborne coal, they were compelled to stock largely; and, as a rule, they held three months' supply, which certainly was a great protection. No doubt there was a deterioration in the quality. Mr. Jones told them some time ago that, if they could give the colliery proprietors orders for a steady, even supply, they would get the coal cheaper; and the reduction in price would go a long way to compensate for the interest which would have to be paid on the coal that was stacked. As to the use of machinery for the haulage of coal, it all depended upon the position of the works. A high-level railway was, no doubt, a very admirable system. At the same time, it was very expensive; and at Oldham it would have cost a great deal more than the elevator machinery. They generally made the conveyor machinery form part of the roof; and they thus obtained more height than was possible by a high-level

railway. This was an important factor in connection with coal storeage; for the object was to get as deep storeage on as small an area as possible. The question of wear and tear used to be a great difficulty; and he was glad to hear from Mr. Chadwick that in this respect the machinery was satisfactory. If they had a little water at the bottom of the pit, and the fine coal accumulated there, a very hard mass would be formed; and there was danger of a large piece of coal catching against this obstruction, and throwing a great strain upon the whole of the apparatus. This could be prevented with care; and the danger would be avoided if the pit were cleaned out weekly, as was done by Mr. Glover. As to the question of the size of coal, all he could say was that there was great difference of opinion on this subject among gas engineers. Machinery could be constructed to break coal to any size required. There was also the point mentioned by Mr. Chew as to the depth of coal-stores. At the East Greenwich works of the South Metropolitan Gas Company, they had gone down some 12 feet below the basement level, in order to get increased depth; and the store there would be a total depth of 25 feet. The subject of conveying coke had received his attention. Some experiments had been worked out by Mr. Charles Hunt and himself; and he had no doubt that the apparatus would succeed. He was working in the direction of putting up stronger machines than formerly. Gas-works machinery had to work night and day; and it was necessary that the mechanism should be stronger than the ordinary engineering theories provided for, so that the wear and tear might be reduced to a minimum.

Mr. W. S. Haddock (Warrington) referred to the method used at his works for dealing with the coal, and said it would not cost 2d. per ton. The waggons were opened and the coal delivered in the store at the rate of one waggon every quarter of an hour.

Mr. Chadwick briefly replied to the various objections which had been raised. He agreed that it was desirable to have freshly-won coal; but they could not get it in the winter, and stacking to some extent was therefore a necessity. As to breaking coal, he did not believe in breaking it too small. They could not all buy nuts, as Mr. Shires suggested they should. At Oldham they had coal of all sizes; and, as he explained in the paper, the smaller pieces went through the breaker, while the larger lumps were broken. If they were sending nuts through, they would not be broken; while if they were sending soft Durham coal through, they would put a baffle-plate in, so

as to prevent it getting into the pit faster than the elevator could take it up. The rollers could be altered, and the coal broken to any size. In his case, he did not keep the coal in stock for any length of time, as he was constantly using it. They had no stoking machinery, so that they had to handle all the coal as it came out of store. The calculation he had made, as to the amount saved by the use of machinery, included the interest on the outlay and the estimated wear and tear. In three years' working, the only breakdown was when the strap broke once; and the cost of repairs had only been about £10. The band of the conveyor, as he had explained, was made of layers of cotton cloth, which was strongly woven; and they occasionally ran hot tar over it to preserve it. So far, more than 100,000 tons of coal must have gone over it; and it would last many years longer. It was about 26 inches wide. The top pulleys on which it worked were hollowed a little; so that the coal falling on the band had a tendency to "dish" itself. This, however, was not necessary; and a flat belt would, he believed, be better, for the coal had no tendency to work off the edges.

A hearty vote of thanks was accorded to Mr. Chadwick for his valuable and interesting paper; and the business of the meeting closed.

The members afterwards had tea together.

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Browne, A. F. . . . . Rotherhithe.
Carpenter, C. C. . . . . Vauxhall.
Carpenter, S. . . . . Dorking.
Carvossa, J. H. . . . . Dartford.
Chapman, J. L. . . . . Harrow.
Child, W. D. . . . . Romford.
Church, J. . . . . Westminster.
Cooper, W. R. . . . . Banbury.
Couper, R. M. . . . . Newbury.
Cowney, J. . . . . Seaford.
Creighton, J. . . . . Mill Hill, N.W.
Davis, J. . . . . Gravesend.
Dexter, F. G. . . . . Winchester.
Dougall, A. . . . . Tunbridge Wells.
Dougall, J. S. . . . . Boston.
Durkin, S. W. . . . . Southampton.
Eldridge, J. . . . . Oxford.
Ellery, C. S. . . . . Bath.
Farrand, C. . . . . Coventry.
Gandon, C. . . . . Crystal Palace District
Gandon, J. . . . . Smyrna. [Gas-Works.
Garnett, G. . . . . Ryde.
Goddard, D. F. . . . . Ipswich.
Green, B. . . . . Mitcham.
Grimwood, C. W. . . . . Sudbury.
Hamilton, H. . . . . Chertsey.
Hammond, J. . . . . Eastbourne.
Helps, D. H. . . . . Croydon.
Helps, J. W. . . . . Croydon.
Herring, R. . . . . Dover.
Hicks, W. G. . . . . Ascot.
Humphrys, N. H. . . . . Salisbury.
Hunter, J. . . . . Plumstead.
Irving, D. . . . . Bristol.
Jolliffe, J. T. . . . . Ipswich.
Jowett, T. . . . . East Grinstead.
Lane, G. . . . . Aylesbury.
Latchford, W. J. . . . . Broadstairs.
Legg, H. . . . . Herne Bay.
Linging, F. E. . . . . Norwich. [Works.
Livesey, F. . . . . South Metropolitan Gas-
Livesey, G. . . . . Tunbridge Wells.
Marsh, G. F. . . . . Buckingham.
Martin, T. H. . . . . Barnet.
May, T. . . . . Canterbury.
May, T., jun. . . . . Richmond.
Methven, J. . . . . Nine Elms, S.W.
Mimmack, W. B. . . . . St. Mary Cray.
Mitchell, A. . . . . Bury St. Edmunds.
Mitchell, H. G. . . . . Hornsey.
Morton, J. . . . . Ashford, Kent.

Morton, R.	Blackheath, S.E.
Nixon, T. H.	Old Kent Road.
Onslow, A. W.	Woolwich Arsenal
Owen, W.	Horley.
Packham, H. F.	Kingston-on-Thames.
Parlby, W.	Hereford.
Penny, S.	Uxbridge.
Phillips, A. F.	St. Albans.
Price, E.	London.
Price, T.	Hampton Wick.
Price, W. E.	Hampton Wick.
Randall, W. B.	Waltham Cross.
Ritson, T. N.	Kendal.
Ruggles, C. F.	Leighton Buzzard.
Sapey, E. T. D.	Horsham.
Smallbone, F.	Hoddesdon.
Smith, J.	Sunbury.
Smythe, H.	Maidstone.
Syms, W.	Rochester.
Temblett, S.	Andover.
Thomas, R. P.	Ware.
Thorman, J.	West Ham.
Thurlow, F. W.	High Wycombe.
Tysoe, J.	East Greenwich
Valon, W. A.	Ramsgate.
Wadeson, J.	Windsor.
Walker, W. A.	Worthing.
Watson, J. C.	Lower Sydenham.
Webb, T.	Egham.
West, J.	Manchester.
White, T. W. R.	Sherborne.
Wilson, G.	Lewes.
Wilton, J.	Silvertown.
Winter, A. F.	Sevenoaks.
Wood, W.	Walton-on-Thames.
Woodall, C.	Palace Chambers, Westminster.
Woodward, W.	Bromley.

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